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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

Identical Twins Reared Apart

(See Page 433)

Production of Triploid Plants
John Belling

Evolution Up and Down
Review

DECEMBER, 1925 VOL. 16, NO. 12

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"WHAT EITHER MIGHT HAVE BEEN"

Frontispiece

On left: B, taken in June, 1923, in Wyoming; on right: J, taken in September, 1923, in Arizona.

MENTAL TRAITS AND HEREDITY

The Extent to Which Mental Traits Are Independent of Heredity, As Tested in a Case of Identical Twins Reared Apart

H. J. MULLER

*University of Texas**

I. The Problem

THERE can be no doubt that the characters whose inheritance is of paramount importance to us are human psychological traits. What makes the world today, as well as what directly makes ourselves what we are, is man's psychology. To attain an understanding of, and finally the guidance of the heredity of man's own psychological nature, must for a long time to come be the hoped-for ultimate goal of applied genetics, far overshadowing any of its other possible attainments.

Our direct efforts at reaching an understanding of the heredity of mental characters have so far been largely confined to the recording of pedigrees, in which traits of the individuals, such as mental capacity, or immorality, or patience, are indicated simply as present or absent, according to some subjective estimate often received at second hand —then, assuming that these assigned differences are mainly genetic in origin, the attempt is made to work out from the pedigree the method of their inheritance. But inasmuch as man's brain is his chief mechanism of adaptation to diverse outer environments, his brain being, primarily, an organ expressly constructed in such a way that it confers upon its possessor the maximum *plasticity* of adjustment known anywhere in the universe, it should be evident that many psychic traits, especially as judged by casual estimate, will be extremely reflective of the environment that the individual has had. And as the human individual tends largely to hand down both his physical and his specific psychic environments, such as amount of schooling, habits of ill-temper, alcoholism, etc., *ad infinitum*, there will thereby be created in the pedigrees a false appearance of inheritance which may be inextricable from the effects of heredity itself. It should accordingly be one of the first concerns of workers in this field to determine how much the traits involved, as estimated by them, are subject to alteration by environmental differences commonly met with, and, secondly, they should seek to find what traits, and what methods of estimating traits, give data least affected by environmental differences and therefore most reliable for genetic study.

In most laboratory animals, the above objects can be attained by inbreeding brothers to sisters for a large number of generations and thus obtaining pure (homozygous) lines, and then studying the amount of variation of different traits, as estimated by different means, within these lines, as compared with the amount of variation between individuals of different lines. In man, this is scarcely feasible "in this day and generation," but fortunately we are presented with material of the type sought for, namely, genetically identical individuals, in the cases of identical twins. Although only two individuals here belong to each pure line, observations on enough pairs should tell us the amount of

*Department of Zoology contribution No. 191.

effect of certain kinds of environmental differences, such as accidents of embryonic history, or incidental daily occurrences, or adult experiences, on all sorts of traits. This was first pointed out by Francis Galton[5], who, after reviewing the histories of thirty-five pairs of probably "identical" twins, came to the conclusion that none of the environmental conditions, except disease, which had differentiated the members of the pairs of twins, had exerted a pronounced effect upon their psychic traits.

Unfortunately for the purposes of the present problem, however, cases of identical twins are usually the very ones in which most kinds of environmental differences, especially those of more protracted action during the earlier more plastic years, are reduced to a minimum, and so these cases can supply us with only very limited data on "genetic indetermination." This criticism holds against the cases of Galton above referred to. Cases are required in which the identical twins are *reared apart,* under environments differing as much as those commonly met with do, in order that we may gain an idea of the amount of effect of such environmental differences as distinguish separate families in a community. Not one such case has heretofore been systematically investigated by modern methods, as such cases are very rare. Each such case is extremely valuable, however, since in any *one* such case, if a mental trait is found which shows marked similarity in the two members of the pair, and wide diversity in other individuals, in spite of the fact that the environments of the two members differed considerably in such features as would be most likely to influence the trait, it may be pretty safely concluded that the trait in question, when measured by the method used, is genetically narrowly determined, and is reliable as a genetic indicator; where, on the other hand, great differences appear, it is highly probable that the latitude of genetic indetermination is great, that the character differences so indicated are largely non-genetic, and that some other method of observation or of testing must be used for estimating the genes which may be concerned in such characters. The results, then, may indicate not only the amount of variation caused by environment in the trait measured, but also the reliability of the method of measurement used, for indicating genetic facts.

Psychological tests of all kinds are much in vogue at present, and have multiplied rapidly. Doubtless their objectiveness and the comparative lack of personal equation in determining the scores make them superior, for most scientific purposes, to the old scheme of using untrained personal opinion as to traits, but until they have been tried out by work of the kind just outlined, the *genetic* significance of these tests, as well as of the earlier methods of estimating psychological characteristics, must remain most dubious. In the present work on a case of identical twins reared apart, then, mental tests of various kinds were used, not because they were highly trusted as indicators of "innate" tendencies or capabilities, but because they were the only kind of objective measures yet available, and because the use of them in this connection might furnish a test of the tests themselves.

The idea of applying mental tests of various kinds to twins had been conceived and already put into operation by Dr. Helen Koch, psychologist at the University of Texas. The pair of twins reared apart, that are dealt with in the present paper, had been brought to the writer's attention through the note by Popenoe, in the JOURNAL OF HEREDITY in 1922, which had given a picture of them and a brief description of their characters and histories, based on a statement

sent in by one of the twins (J.). If, then, these twins were identical, all that was necessary for the present writer to do, in order to obtain evidence on the problems indicated above, was to apply the same series of tests and general technique as was being used by Dr. Koch to the twins reported by Popenoe. This was made possible by the generous collaboration of Dr. Koch, who furnished the present writer with tests of the kind she was using and acquainted him with their technique, and in addition planned a series of questions calculated to give pertinent data in the life history investigation. At her suggestion, funds which helped to defray the expenses of the trip were placed at the disposal of the writer by the Department of Education of the University of Texas. The writer wishes here to acknowledge this assistance and also the efficient and invaluable cooperation rendered by both of the twins, and by the writer's wife, Dr. Jessie Jacobs-Muller.

There was an important reason for giving the twins exactly the same tests as Dr. Koch was using, aside from the greater convenience of such a procedure for the present investigator. If any wide differences should be found between the responses of the two identical(?) twins in the present case, the question would arise whether these differences had really been caused by the conspicuous differences in the rearing and manners of life of the twins, or by other causes—such as temporary moods, or the lasting influence of fortuitous but critical events in the pre- or post-natal life, that might conceivably have caused just as pronounced divergencies between individuals that had been reared together. Although Galton's data above referred to does indicate the slightness of effect of such influences on psychological characters, the latter were not actually measured by mental tests in his work and it might be that the tests would have shown greater differences. Some evidence on the point in question might, however, be gained by noting whether the differences in the results of the tests in the present case were or were not of the sort that might be expected to follow from the ascertainable differences in the life histories of the twins. But the most dependable evidence would be derived from a study of the results of the same tests when applied to twins reared together. When the results of the study undertaken by Dr. Koch appear, therefore, they should have an important bearing on the present case, in indicating how much any differences here found are really attributable to the differences in "upbringing" of the twins, rather than to the other environmental factors above alluded to.

II. The Determination of Genetic Identity

The problem next arose, of how the genetic identity or non-identity of the twins could be established. For this a new method had to be devised. A list of largely non-correlated physical traits was drawn up *a priori*, such as stature, coloration, prominence of chin, curling of hair, etc. In doing this the attempt was made to choose traits (1) in respect to which marked differences, readily noted, are commonly to be found within families, (2) which there would be as little *a priori* reason as possible to suspect would be connected in development, or influenced by the same genetic difference, (3) which general observation indicates often to be inherited separately from each other within families, and (4) which are probably influenced as little as possible by environic differences. What, now, will be the chance, *a priori*, that the twins should agree in some one of these traits in which one or more of the sibs differ from the others, if the twins are not "identicals?" Or what will be the chance that they should resemble each other more closely than they do the other

twins? These chances can be calculated with considerable accuracy.

Let us suppose, first, that in respect to a given trait—say body build—certain "classes" may be distinguished among the sibs—e. g., heavier and lighter build—into which the sibs may be classified in such a manner that all the individuals found to be in the same class clearly differ less from each other than any of those in different classes do. In the present case there were two "heavier" and three "lighter" (including the twins). Now, accepting the given numerical division of the sibs into these classes—e. g., two in one and three in the other in our case,—what were the *a priori* chances that both of the twins should have fallen into the same class? The chances are in our case two in five that one of them should have fallen into the heavier class, and, this being so, one in four that the other should have fallen into this class, or $2/5 \times 1/4, = 1/10$, that both should be in the heavier class. Similarly, the chances are $3/5 \times 2/4$, or $3/10$, that both should be in the lighter class, and the total chances that both should be in the same class, either heavier or lighter, are $1/10 + 3/10$, or $4/10$. In general, if there are n sibs altogether (including the twins), a of them falling into class a with respect to a given trait, b into class b, c into class c, etc., the chance that the twins should have been found in the same class is:

$$\frac{a}{n}\cdot\frac{a-1}{n-1} + \frac{b}{n}\cdot\frac{b-1}{n-1} + \frac{c}{n}\cdot\frac{c-1}{n-1} + \text{etc.}$$

If, now, the traits are inherited independently, as they usually will be to a large extent, the chance that two sibs should be in the same class in respect to all the traits considered is the product of all these chances found in the case of each separate trait. By this means it was shown that, if the twins in the present case were non-identical, the chance that they should have been in the same class, as they were, in respect to all the six traits thus investigated was only 1 in 386 (see table A). The latter number would probably have been even higher, were it not for the fact that in a number of cases (marked "?") the class of a sib in regard to a given trait had not been definitely determined and in these cases the sib had been reckoned as belonging in the same class as the twins, in order that any mistake in the final number should be on the side of caution.

If actual measurements could be made of the traits in each sib, instead of a mere division into "classes," a much more exact estimate of the probabilities could be made. For $2(n-2)$ resemblances exist between each of the two twins and each of the $(n-2)$ sibs other than the twins, in any given trait, the resemblance between the twins themselves therefore being only 1 in a total of $2(n-2) + 1$, or $2n-3$, resemblances; the chance, then, that the resemblance between non-identical twins is closer than the resemblance of either to any of the other sibs, in a given trait, is $\frac{1}{2n-3}$. For this relation to hold for all of m traits, the chance would be $\left(\frac{1}{2n-3}\right)^m$

If the relation failed to hold in the case of any traits the chance could also be calculated of the resemblance being as close as it was found to be. It is important that the investigation be made of traits chosen *a priori*, or at least before their extent of development in *two* of the sibs (including at least one of the twins) is known, else the investigator may be more apt to choose for investigation traits in which the twins differ from other sibs, and agree with each other.

After we have established the chance $\frac{1}{P}$ — $\frac{1}{386}$ e. g. —— in our case—that non-identical twins would agree so closely, we may then legitimately turn this statement around, to say that the chance, in such case, that the twins are identical, is approximately $\frac{P}{P+1}$ i. e. $\frac{386}{387}$. The latter calculation assumes that identical twins would always fall into the same "classes," or agree more closely than ordinary sibs, in the traits studied. Then, since approximately half the cases of twins of the same sex are "identicals" (as shown by the fact that twins are of the same sex twice as often as of opposite sex), we should find, in a collection of 2P pairs of twins (772), P (or 386) identicals, all agreeing closely, and P (or 386) non-identicals, of which only one pair agreed as closely as in the case observed. Hence, amongst each P+1 (387) that resembled each other by the required amount, only one pair would be non-identical, and the chance that the observed pair was one of the identicals would be $\frac{P}{P+1}$, i. e., $\frac{386}{387}$

The above methods can be used in all cases where a pair of twins have another sib concerning whom information can be obtained, and they should prove useful, as the crucial question of whether or not a given pair of twins is identical could heretofore be answered only very vaguely. These methods are themselves still capable of considerable refinement, however, and as yet yield results only approximately correct, inasmuch as they do not take into account discrepancies caused by possible association of the traits considered in a family, due either to linkage or to their dependence on identical factors, or possible evironic effects that might occasionally cause identical twins to differ more than ordinary sibs in a given trait, or cause non-identical twins to be more alike than ordinary sibs. The method of *a priori* selection of the traits minimizes these discrepancies, and if the classification instead of the measurement method is used there is little chance that traits like eye color will be caused by environment to overstep their "class" boundaries. However, the precise amount of allowance to be made for each of these sources of inexactness can be definitely determined by statistics involving actual measurements or classifications of the traits in question in ordinary sibs and in twins. These statistics will disclose (1) the amount of correlation of the traits amongst sibs within families, (2) the frequency with which identicals show greater differences than ordinary sibs and (3) the amount to which non-identical twins show a greater resemblance than ordinary sibs. In making this determination the genetic identity or non-identity of twins could be established sufficiently well for the first approximation by the methods as given above. When these three values have been found their use in connection with the above methods would render the probabilities yielded by the latter very narrowly accurate, and independent of any assumptions such as those made in the present case.

In this case, in addition to the traits in the *a priori* list, there were striking resemblances between the twins in special points that had not been considered before examination. For example, they both had double ankle prominences on the mesial side of each tibia. Further examinations of the twins were conducted, on various physical characteristics, and when corresponding data can be obtained from the other sibs a considerably higher probability for identity than 386:1 will doubtless be adduced.

It may be of interest to note some

of the results of the examinations (see Table F). The twins were of the same height, to the half inch, and the same weight, to the pound, when examined, though J had a very slightly larger head, and cephalic index, than B. Both belonged in group II with respect to blood agglutinins. Their strength of grip was nearly the same. In their iris color and iris pattern, hair color, distribution, and curliness no difference could be detected. Both had teeth similarly defective. There was a slight asymmetry of incisors, of iris patterns, and of lower lip in both, and, in both, these asymmetries were in the same direction. Both twins, moreover, had early shown lefthandedness, though B had been broken of it. Such asymmetry, in the same direction, appears to indicate earlier separation of the two cell masses of the embryo that were to form the two individuals than does asymmetry in opposite directions (the "mirror image" condition), but it is probably even better evidence of identical twins than the mirror-image condition is when the asymmetry of both is of the more unusual type (like lefthandedness). Finger prints showed themselves, in this case, to be no more definite identifying marks than general cast of features, for there was considerable difference between the two hands of each twin, which was probably due in the main to fortuitous embryological events, since where corresponding fingers of opposite hands of one twin differed in type from each other both these fingers of the other twin were of the same type as one of those of the first twin. In this respect, then, the asymmetries of the twins did not correspond, neither were they mirror-images, yet if the right hand of J had been interchanged with the right hand of B the twins would have had hands which matched each other—right with left of the same twin—about as well as before the exchange. The finger nails of the pair were very much alike. The features were very similar in the more easily definable aspects of contour and also of expression, and the twins have often been mistaken for each other; nevertheless there seemed to be distinct differences in the impression created on the observer. These differences were partly, but by no means entirely, due to the effect of differences of dress and of dressing the hair, and to the effect of a nasal operation on J.

III. The Histories of the Twins

A detailed study of the past history of the twins was made when they were visited and given the tests in the summer of 1923. B was then living in Wyoming, and J in Arizona. They were thirty years old at that time. They had been separated when two weeks old, did not see each other until they were eighteen years of age, and since then have lived in different places over nine-tenths of the time. Although they were brought up in a rather similar social and material environment, in the northwestern mining and ranch country, there were important differences in their upbringings, as will be seen from the following brief sketch.*

B was brought up by foster parents who did mining, logging, and hauling, and often changed their locality. B as a child was out with the teams all day and had only four years formal schooling altogether, including nine months in business college. At fifteen B obtained clerical work, and she has had a strenuous but successful business career, varied by clerical, administrative, and secretarial work in many places—in Montana, Wyoming, New York, Washington, D. C.,

*Mimeographed copies giving all the details of the life histories which came to light, so arranged that corresponding features in the lives of the two twins are placed in juxtaposition in parallel columns, will be mailed to geneticists or psychologists interested, upon application to the writer.

California, and in France during and after the war.

As for J, her foster parents owned a ranch and roadhouse, where things were very lively and she saw much of people when a child. She, too, was outdoors much of the time, and, like B, was a "tom-boy," but, being better off (tho not better educated), J's folks sent her right through school and through high school, and she has since had some summer university work. J has stayed west (mainly in South Dakota), and taught school there until her marriage nine years ago. (At this time B had a broken engagement.) J has had a child and is now teaching again, her especial interest being in education.

Both twins read voraciously when children, and have always been intellectually active, so that their class room work by no means measures the extent of their real education. Both have been extremely energetic, capable, and popular, and they have been prominent in all sorts of club work in their respective communities. On casual observation they appear very similar in character.

It appears that J was by far the healthier baby, probably because of better treatment, B, the "runt," being badly fed and given much laudanum; B has had stomach trouble ever since. Both have had two or three attacks of tuberculosis, almost simultaneously. B had, and J nearly had, a nervous breakdown in her late teens.

IV. Results of the Psychological Tests

The twins were given two so-called "intelligence tests" which are well known in America: firstly, the "Army Alpha Test" (Form 8, July 9, 1918),[3] which is doubtless familiar to most of the readers of this article at first or second hand, and secondly, the "Otis Advanced Intelligence Test" (Form A, 1922),[4] which is very similar in character. The total scores (see Table B) were almost identical—B obtaining 156 and J 153 on the former, B 64 and J 62 on the latter. Scores so high are taken as indicating "very superior intelligence;" they are not common amongst persons attending school or college, except amongst students in universities of high standing, and they occur very seldom amongst persons of the social class in which the twins were raised.

The very extensive tests of the army draft showed that scores above 135 (called "A") on the Army Alpha occur in only about one in twenty-five men drawn at random from the general white population, and, as the results from persons of different occupations show, such scores can certainly be no more frequent than this amongst men whose parents belong to the social class to which the foster parents of the twins belonged. Further data on various groups shows that amongst persons of grade A (i. e., above 135), nearly half have scores below those of the twins (even in groups in which relatively high intelligence is expected); hence the *a priori* chance of a man with the social origin of the twins attaining as high a score as they did on the Army Alpha test is about one in fifty; data show that the chances are not higher for women than for men. But the chance for an individual of such origin not only attaining approximately as high a score as either of the twins, but also a score differing from one of these by no more than these differed from each other, is very much smaller yet, for much less than a fourth of individuals having scores as high as either of the twins fall within the range between them,—accordingly one in two hundred would be an ultra-conservative estimate. When in addition we take into consideration the consistently very high Otis scores, and their close parity, the chance becomes even more reduced. If the tests have no genetic significance, then, the chances were decidedly over two hundred to one against obtaining such a coincidence in scores

as was observed. In fact, unless the correlation between genetic composition and test scores were very high (for individuals of a given region and status) the chances of getting a result like the above would still have been exceedingly small.

It should, however, be noted that the twins' responses were not equally alike throughout all sections of the tests. For in one section of the Army Alpha in particular—that known as "analogies," where a fourth suitable term has to be found for series like "sky: blue:: grass: (table, green, warm, or big?),"—"green" here being the correct answer—the scores seemed significantly different, B obtaining fourteen and J twenty-five out of forty. This difference is three times its "probable error," representing a chance of not more than one in twenty (even if all questions had been equally hard for a given twin). Yet on the face of it this would appear to be a test most indicative of innate analytical ability—if any such general ability exists. B answered seven and J eight out of ten correctly, however, on the similar section of the Otis test. A possibly significant difference in the other direction was found in the arithmetic scores: 15 for the clerical but less schooled B, 11 for J, out of a total of 20, in the Army Alpha; 10 for B and 6 for J, out of 10, in the Otis. Yet arithmetical problems also are sometimes considered particularly good tests of "reasoning ability," if any such general ability exists. The only other difference of any account at all was in the results of the "synonym-antonym" tests of the Army Alpha (section 4), where B scored thirty-nine, J thirty-two out of forty, but in the rather similar section of the Otis test both scored eleven out of eleven. The similarity in scores of all other sections was extremely close, especially when the scores in corresponding sections of both tests were added together.

On the whole, then, we return to the conclusion, for most individual sections of these tests, that, when applied to persons of a given social class and territory, they provide a fairly reliable index of genetic or inherent capability for work of this nature; or, one may say, the expressions of intelligence measured by most sections of these tests are little affected by environmental differences, such as kind of schooling, occurring within the limits of such a class. (Note that the twin with less regular schooling scored slightly higher, if anything, in "intelligence.") We must, however, be careful not to draw the more sweeping conclusion from these results that environmental influences in general would have little effect upon scores attained, because the twins were after all raised in the same kind of community, and in families of a similar status; what the effect might have been of changing the social class, the country, or the color (were that possible) of one of them, it would be impossible to predict from present data.

Let us now compare with the above the results of other psychological tests, not of intelligence, but of volitional traits, of effort, emotional trends, social attitudes, etc. A glance at Tables C, D and E reveals the utterly different character of the findings. In Table C, for example, we see that J, the more schooled, responds about twice as rapidly to the stimulus-words in the Kent Rosanoff Association Test—tho her responses involve correspondingly more superficial associations. Such a difference is commonly found between the more and the less drilled in classrooms. But B, the typist, "naturally" can make much faster taps, and she likewise makes faster dash marks within the squares of cross-section paper, tho here she is correspondingly less accurate.

In the Pressey X-O Tests for emotions and social attitudes (Table D) the subjects are given various selected lists of words, with instructions to

cross out those representing things that they like, dislike, worry about, or have other specified attitudes towards (according to the section of the test). The results of these tests show that B—who has been so much knocked about—is much less perturbable in every way: she is less unpleasantly aroused either by things that might excite disgust, fear, sexual associations, or suspicions, having far fewer dislikes in all than J, and far fewer than the "norms," whereas J has more than the average number. B also has a smaller list of worries, and a smaller list of things she regards as wrong. In both these latter respects J is considerably above the average and B is approximately average. Part of the differences in fears, wrongs, and worries may also be explained by the fact that J had a much more fearsome, worrisome foster mother than B, and that she now has a family herself. On the other hand J, having more school training, exhibits more associations. She also has developed more likes.

The differences in results in the Pressey Tests are on the whole of the same order as for two unrelated persons taken at random from the group on which the norms of the test were based. In fact, the differences in results in Form A of these tests averaged just 1.0 times the average (or rather, median) difference between two individuals taken at random from this original group. (For the differences in Form A scores between B and J average exactly $\sqrt{2}$ times the quartile deviation of the whole group.) Certain sections of the Pressey tests (Form B) are taken a day or two after the rest, and the first two sections of the latter involve a repetition of some of the kinds of work previously done; this gives us a check on the previous results. In such cases (indicated in the rows marked "Form B") each twin gave answers fully consistent with those given by her before, and entirely different from those of the other twin. The difference between the responses of the twins in Form B is about one and one quarter times the average (median) difference between two individuals selected randomly from the group that was originally studied by Pressey.

In the Downey "Will-Temperament Test" (Table E) the twins made scores that were at least as different from each other as were those of the Pressey tests. In the Downey test the examinee is assigned various tasks, such as writing as fast as possible, and as slowly, and, again, under various circumstances that may try his patience, his temper, his perseverance, etc. He is also given certain decisions to make—and later to unmake, if he so chooses. In these acts he is taken off his guard, however, as the real object of the test is generally hidden under the cloak of some other ostensible purpose; so there is little chance for the tell-tale reaction to be purposely strengthened, weakened, or disguised by the subject.

The scores of these tests, marked off as points on a scale, and connected by lines, as in the table, are called the "Will-Profile." It will be seen that in nine of the twelve cases, where one twin's score was above the median (5.5), the other scored below, so that in this sense the scores were almost opposites of each other. The scores differed from each other, on the average, by four points, whereas the average (or rather, median) difference in scores of individuals chosen at random from the group on which the original data concerning the test were secured by Downey was 3.5 (as calculated from the quartile range, 2.5). Examining some of the individual records, we see that B—who has long been the director of clerical underlings and who in childhood was systematically tormented by her foster brother—reacted much more strenuously to contradiction (No. 6), and to opposition (No. 7), than J, the married. She also showed (so far as

her responses to the tests could be taken as indicative) greater power of speedy movement (No. 1), went more nearly at her top speed habitually (No. 2), and had greater ability to do several things at once (No. 11), than J, but she was far less patient (No. 9), less really interested in detail on its own account (No. 10), less "flexible" (No. 3), and less likely to change previous decisions (No. 8), and not quite so desirous of continuing the work on her own initiative (No. 12).

The responses of the twins to all these tests—except the intelligence tests—are so decisively different almost throughout, that this one case is enough to show that the scores obtained in such tests indicate little or nothing of the genetic basis of the psychic make-up. And yet the results of such tests have, it is claimed, been shown to be correlated distinctly with characteristics of importance in the conduct of life, and in the successful holding of various types of positions. If, then, traits apparently so important, and so objectively defined as these, are not fixed by heredity, it is still more probable that many of the psychological differences commonly shown in human pedigree charts likewise have no genetic basis, and it is necessary to institute an intensive search for ways of identifying more truly genetic psychic characters.

Such an investigation can be conducted, firstly, by more thoroughly studying the effects of differing environments on identical twins, as well as (with certain checks and precautions difficult to realize in practice) on the same individual; secondly, by noting the differences and likenesses in response of individuals of different ancestry raised in the same general environment (as in orphanages or by foster-parents), and correlating these responses with those of their relatives and of their educators; thirdly, by studies of linkage or other genetic association between definite physical or physiological traits, that may be used as "identifying characters," and psychic reactions. The first two kinds of studies involve further developments in psychology. The third (as pointed out by Altenburg and the present writer in their study of truncate wing inheritance in the fruit fly, where such methods were first used in analyzing a modifiable character), requires also a much higher development of the study of human heredity. For this purpose knowledge is needed of the inheritance of numerous human character differences commonly met with that may seem unimportant in themselves: a fuller elucidation of this matter has been given in the paper above referred to [1].

V. Results of General Observations on Traits of the Twins

In the present case of identical twins reared apart, indications are not lacking, despite the diverse reactions to almost all the non-intellectual tests used, that there are really many other mental characteristics in which the twins would agree closely could we but find appropriate means of measuring them. Thus, as previously noted, the twins both seem possessed of similar energy and even tension, in their daily activity, with a tendency to "overdo" to the point of breakdown; both have similar mental alertness and interest in the practical problems about them, but not in remote or more purely intellectual abstractions and puzzles; both are personally very agreeable (as indicated by their popularity); both displayed similar attitudes throughout in taking the tests, even to such details as lack of squeamishness in blackening the fingers for the fingerprints, and in being pricked for the blood test—but turning away before the needle struck. The tastes of both in books and in people appear very similar. It would seem, then, that the operations of the human mind have many aspects not yet reached by psychological testing,

and that some of these are more closely dependent upon the genetic composition than those now being studied.

The twins themselves both believed their likenesses far to outweigh their differences. Whether or not these opinions were mainly due to unconscious bias favoring the finding of similarities (they were very fond of each other), or to inadequacy of the psychological tests in disclosing many important traits, it is difficult to decide. However that be, the results of Galton—which were based upon just such personal estimates—are thereby thrown open to a similar question: i. e., psychological tests upon his twins too might have given very different scores despite the alleged likeness in character of the twins. The divergence between his results and those of the present paper may be explained either in this way or on the ground that differences in rearing during the earlier years, such as occurred in the present case, are far more effective in modifying mental characters than differences in adult life, which operated in Galton's cases.

The conclusion that there were really marked psychological differences between the twins in the present case does not rest solely upon the results of the tests, however, for we have also found apparent differences between the twins in various important particulars that were not subjected to measurement. Such differences are at once evident on comparing the brisk, correct, and business-like style of a letter written by B, with the more "homey" and sympathetic tone of a letter by J, who, despite her formal schooling, has much less perfect command of English than B. A similar impression is produced on the observer interviewing them. Turning to their more general attitudes, it is claimed that B has always been much less fond of children than J, who was brought up with so many more children about her (but B now seems to be changing in this respect). Again, J, brought up in such a lively home, seems to have been much more "vivacious," in the sense of caring for social affairs, "dates" with men, etc.—but the meetings between B and J and their months of life together since eighteen years of age are said to have exerted a marked effect upon B in these matters, as well as in other respects, making her much more like J. B had a period of great religious fervor in her teens, before her nervous breakdown, with leanings towards Catholicism; she has since been very liberal in religious matters. J had no such great religious outburst during youth, but since her last illness, which was more severe than B's, has turned to Christian Science. There are also some sharp differences in their attitudes towards minor conventions, partly traceable to experiences during the war.

Such differences as those just noted, then, supplement those shown in the volitional and emotional tests, in indicating the great latitude of genetic indetermination to which many psychic characters of man must be subject. The whole problem is thus seen to be an extremely complicated one, and it will in the future require the efforts of an army of psychologists and geneticists to help untangle the skein of psychic determination. In so doing, they must attempt to ascertain in quantitative fashion how much, and how commonly, various "traits" are affected by environic as compared with genetic differences, just what causal agents are involved in each trait, and what methods of measurement are the best for a given purpose. On the other hand, the demonstration that the determination of mind in civilized communities is by no means purely and simply a matter of the hereditary elements, or genes, should not be a source of discouragement or despair, for in the characters the genetic indetermination of which

is found to be great lies the hopeful field for the educator, and for the agent of social reconstruction.

Summary

1. A new method is presented for determining the degree of probability that twins are genetically identical, when information concerning one or more of their other sibs can be obtained. Applied to the present case, the method yields a probability of approximately 386 to 1 that the twins here studied are identical genetically.

2. "Intelligence tests" applied to these twins yielded scores very significantly alike, despite great differences in the amounts and kinds of the formal schooling they have had, and other environmental differences dating from two weeks of age onward. J (the more schooled), however, had a considerably higher score in the section of the Army Alpha test dealing with more abstract word relations, while B scored slightly higher in arithmetic and in the section of the Army Alpha test involving rapid distinction between synonyms and antonyms. Only the difference in arithmetic was borne out in the Otis tests. In general, it may be concluded as probable that most sections of the Army Alpha Test and the Otis Advanced Intelligence Test yield results highly correlated with the genetic basis of intelligence (or at least, of those aspects of intelligence therein dealt with), *when they are applied to individuals brought up in the same general territory and social class.* Were there no such genetic basis for the scores of the twins, the chance for them to have been as much alike as they were would have been less than 1 in 200.

3. The non-intellectual tests—of motor reaction time, association time, "will-temperament," emotions and social attitudes—gave results in striking contrast with those of the intelligence tests, in that the twins made markedly different scores on all these tests. The differences were, on the average, slightly greater than the median differences between the scores of two individuals chosen *at random* from the groups in which the "norms" of the tests had been established. Many of the differences in responses of the twins seemed, moreover, to be correlated with salient differences in their past experiences and habits of life. Scores made on such tests, therefore, would seem to be of little value in indicating psychological differences determined by heredity, however useful such tests may be in enabling us to predict an individual's behavior.

4. If the above is true of traits as measured by tried psychological tests, the results of which seem to be correlated with success or failure in various walks of life, it is probably also true that many of the psychological traits assigned to individuals in the familiar human pedigree charts, on the basis of the personal opinions of varying casual observers, are even less trustworthy genetically. But in so far as such unmeasured traits may be determined by specific familial environments that can be handed down through habit, training, material and social circumstances, they may present in the charts a semblance of hereditary transmission, which is really spurious.

5. It is important, therefore, that research be carried further for the finding of better means of ascertaining such truly genetic differences as undoubtedly do underlie much human psychological variation. Three chief lines are pointed out which such research may follow, including further intensive work on human identical twins.

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TABLE A—CLASSIFICATION OF THE TWINS AND THEIR SIBS, FOR DETERMINATION REGARDING GENETIC IDENTITY

	Height	Build	Color	Hair	Chin Prominence	Nose Form
Twin B	Med.	Light	Med.	Wavy	Decided	Straight
Twin J	Med.	Light	Med.	Wavy	Decided	Straight
Elder Brother	V. tall	Light?	V. dark	?	Moderate	Roman
Younger Brother	Med.	Heavy	V. light hair; eyes brown	?	Decided	?
Younger Sister	V. short	Heavy	V. light hair and eyes	V. curly	Decided	?
Chance of any two being in the same class	.3	.4	.1	.6	.6	.6

Product of chances $= .002592 = \frac{1}{386}$

(Where character was undetermined (marked '?'), sib was regarded as in same class as twin for the calculation.)

TABLE B—INTELLIGENCE TESTS

I. Group Examination Alpha. Form 8, 1918 (U. S. Army).

Designation of Sections	*Scores of:* B	J	*Max'm'm Possible*
1. Hard directions	8	10	12
2. "Arithmetical problems"	15	11	20
3. "Practical Judgment" (as shown by selection of best answers in multiple choice)	12	11	16
4. "Synonym-Antonym Test" (involving rapid decision as to whether words are same or opposite)	39	32	40
5. "Disarranged Sentences" (involving facility in recombining words into proper order and deciding truth of statement)	21	21	24
6. "Number Series Completion" (involving ready comprehension of numerical series)	12	9	20
7. "Analogies" (involving ability to grasp and apply abstract relations between words)	14	25	40
8. "Information Test"	35	34	40
Totals	156	153	212

II. Otis Self-Administering Test of Mental Ability; Higher Examination: Form A, 1922.

Classification of Questions. (Adapted by Present Writer for Comparison with I.)	*Scores of:* B	J	*Max'm'm Possible*
1. Hard directions (involving ability to manipulate elements and positions)	5	6	8
2. "Arithmetical Problems" (as in I)	10	6	10
3. Logical relations, as shown in rational completion of sentences	17	16	17
4. Opposites test (involving rapid selection of words of different meaning, in multiple choice)	11	11	11
5. "Disarranged sentences" (involving facility in recombining words into proper order)	2	2	2
6. "Number series completion" (as in I)	0	2	3
7. "Analogies" (as in I)	7	8	10
8. "Proverbs" (involving ability to analyze precisely the meaning of statements)	6	6	6
9. Syllogisms (a test of logical reasoning)	3	2	4
10. "Geometrical Test"	3	3	4
Totals	64	62	75

(Scores consist of number of questions answered correctly, except in sections 4 and 5 of Army Alpha Test, in which chance of obtaining correct answer is one-half; in these sections score consists of total number of questions minus twice the number answered incorrectly.)

TABLE C—TESTS OF SPEED OF REACTION

	B	J
I. Kent Rosanoff Association Test. Average time of association per word	2.48 sec.	1.27 sec.
II. Tapping Test. Number of taps in given time	207	164
III. Crossing Test. Number of crosses in given time	63	55
Number of errors in crossing	10	4

TABLE E—DOWNEY INDIVIDUAL WILL-TEMPERAMENT TEST

"Will-Profile" of B shown by solid line that of J by dotted line.

	Designation of Trait	Section of Test
1	Speed of Movement	VI–1
2	Freedom from Load	II–1, 2; VI–1, 2
3	Flexibility	VIII
4	Speed of Decision	I
5	Motor Impulsion	X
6	Reaction to Contradiction	XI
7	Resistance to Opposition	XII
8	Finality of Judgement	XIII
9	Motor Inhibition	VII
10	Interest in Detail	IX
11	Coordination of Impulses	V
12	Volitional Perseveration.	III–2

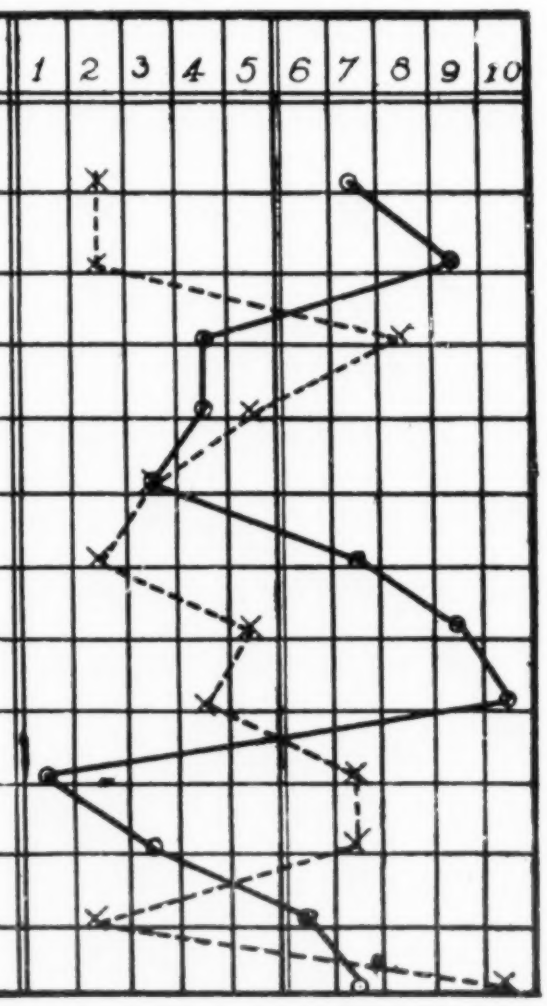

TABLE D—TESTS OF EMOTIONAL AND SOCIAL ATTITUDES
PRESSEY X-O TESTS

Subject investigated:	*Section of Test*	*Number of Words Crossed by*					*Ratio of Twin to Random Difference*
		B	*J*	*Median of Group*	*Upper and Lower Quartiles of Group*	*Upper and Lower Deciles of Group*	
Number of things judged wrong	Form A, III.	72	81	73	60-86		0.5
	Form B, I.	63	88	68		40-97	1.2
Number of causes of worry	Form A, IV.	46	61	46	33-55		1.0
	Form B, II.	38	67	34		15-65	1.6
Number of words with unpleasant meaning:							
a. connected with disgust	Form A, I.	2	16	14.2			
b. connected with fear	"	1	11	8.6			
c. connected with sex	"	4	10	13.0			
d. connected with suspicion	"	0	14	10.1			
e. total dislikes	"	7	51	42	27-56		0.8
Number of likes	Form B, III.	56	76	64		36-90	1.0
Number of associations	Form A, II.	35	56	55	41-70		1.0
Total number of words designated	Form A.	160	249	230	200-260		1.6
	Form B.	157	231	168			
Total number of deviations from averages in responses	Form A.	64	45	49			
	Form B.	48	45	41			

("Random differences" are taken as $\sqrt{2}$ times average difference between median and quartiles of the group. The last column gives the ratio of the twin difference to the corresponding random difference.)

TABLE F—SALIENT PHYSICAL OBSERVATIONS

	B	*J*
Height	62½ inches	62½ inches
Weight a. when tested	110-111 lb.	110-111 lb.
b. maximum	123½ lb.	138½ lb. (before childbirth)
c. adult minimum	104 lb.	99 lb. (after childbirth)
Head length	17.9 cm.	18.1 cm.
Head width	15.2 cm.	15.4 cm.
Iris color and pattern	(1) Innermost zone of light brown fibers. (2) Adjacent zone of whitish radiating branched filaments, with some light brown "spokes" interspersed. (3) Imbedded in zone (2), particularly in left eye, some dark brown patches. (4) Outer zone of light brown fibers. (5) Dark homogeneous outer border.	Same 5 characteristics as noted in case of B. (Resultant effect "hazel" in both twins.)
Mouth	Droops slightly towards left.	Droops slightly towards left.
Teeth	(1) All molars filled several times. (2) Have tendency to be too strongly implanted. (3) Only corners of wisdom teeth came through. (4) Upper right incisor overlaps left.	Same 4 characteristics as noted in case of B.
Finger nails	(1) Flat. (2) Somewhat large, but (3) little finger nail proportionally smaller. (4) Middle finger nail triangular.	Same 4 characteristics as noted in case of B.
Glove size	6⅛	6⅛
Strength of grip (maximum dynamometer readings):		
Right hand	39	36
Left Hand	35	36
Structure of tibia	Presence of additional ankle prominence on mesial aspect of tibia, below the normal prominence.	Additional ankle prominence as in B.
Blood group	II	II

BUD SELECTION IN WASHINGTON NAVEL ORANGE

V—Progeny Test of a Sheepnose Limb Variation

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A NUMBER of bud variations of the Washington Navel Orange have been described and their relation to the origin and development of important strains of this variety has been discussed in an earlier publication.[1] The results of several progeny tests of limb variations, showing certain striking differences in quantity and quality of Washington navel orange fruits have also been presented[2] proving that such variations were perpetuated through bud propagation. Another striking difference in fruit quality which has been found as a limb variation in a tree of the Thomson strain of the Washington Navel Orange is described in the following pages and the performance record of its progeny is presented.

The Sheepnose Strain

The term "Sheepnose" has been adopted for this strain on account of the similarity in shape of its fruits to that of the Sheepnose apples.

The trees of the Sheepnose strain are more finely branched and have smaller, narrower and more sharply pointed leaves than is the case with trees of the Washington Strain.

The fruits are characteristically small in size, ovate in shape with a peculiar and characteristic protrusion of the distal ends due to the development of an abnormally large navel or secondary orange at the tip of the fruit and usually enclosed within it. The texture of the rind is coarse, and many of the fruits are wrinkled or ridged especially at the stem ends. The rinds are thick, the rag coarse and abundant, the juice small in quantity and of poor flavor. The trees are prolific bearers and tend to produce a larger number of fruits than do trees of the parent Thomson strain under similar environmental conditions. On account of the shape of the fruits, their small size, coarse and ridged texture and the inferior quality of the juice, the Sheepnose strain is an undesirable one for commercial culture in the Southwest.

The Sheepnose Limb Variation

The parent tree of the Thomson strain of the Washington Navel orange on which this Sheepnose limb variation was discovered is located in the Eureka orchard of the National Orange Company near Riverside, California. The fruits of this tree aside from those borne by the limb variation are normally typical of the Thomson strain, but rather marked individual fruit variations have been found from time to time. These variations include fruits having a rougher texture somewhat like that of fruits of the Washington strain and in a few instances abnormally shaped oranges with large protruding navels have been found.

This Sheepnose limb variation is a small branch located low down on the South side of the parent tree. All the fruits produced on it each year have been typical of this strain. Figure 1 shows a portion of this tree including the Sheepnose limb and Figure 2 shows fruits produced on this limb and on the normal part of the same tree.

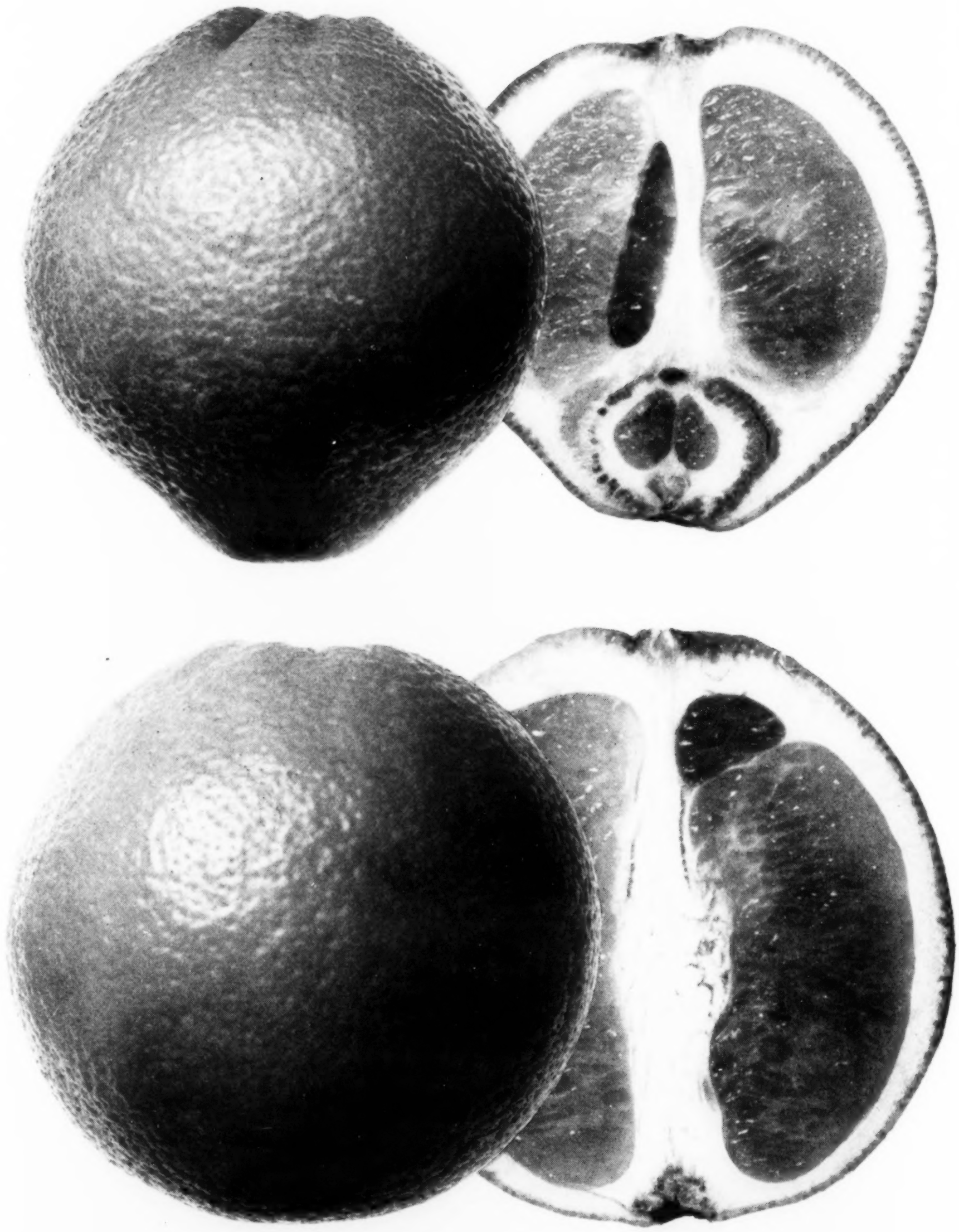
Progeny Propagation

Budwood was secured from the Sheepnose limb variation on January 25, 1915, and propagated on sour

PARENT TREE OF SHEEPNOSE STRAIN

Figure 1

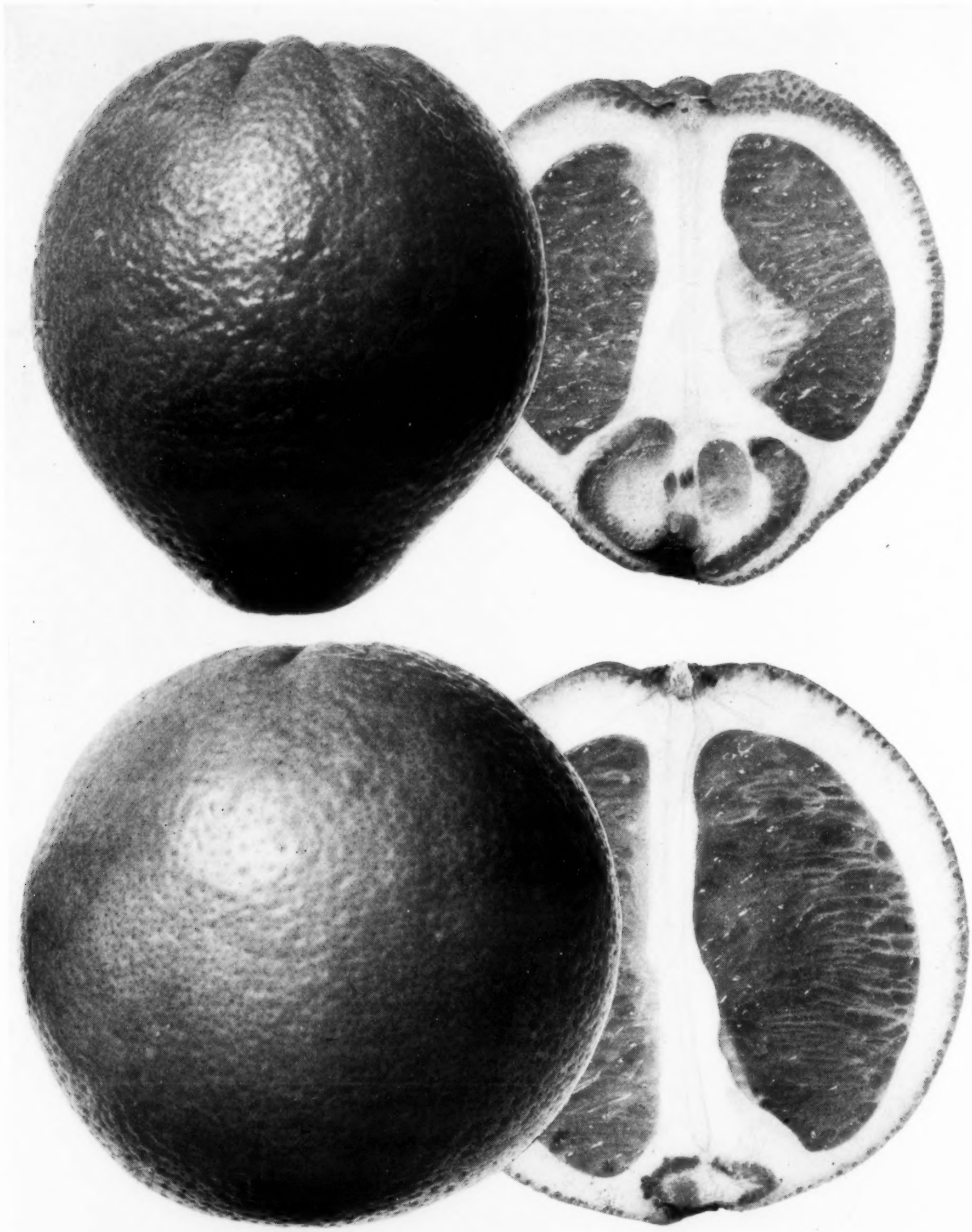
This Thomson tree produces normal fruit except for the one branch which is shown here. On this all the fruits are of the peculiar "sheepnose" type. Photographed at the Eureka Ranch of the National Orange Company, Riverside, California, November, 1924.



FRUITS FROM TREE WITH SHEEPNOSE LIMB VARIATION

Figure 2

Fruits from the sheepnose limb are compared with those from the normal part of the tree. The location of this limb is shown in Figure 1.



FRUITS FROM PROGENY TREES

Figure 3

The fruits are from the trees shown in Figure 4. The sheepnose characteristics are transmitted by budding as well as those of the normal Thomson strain.

PROGENY TREES PROPAGATED FROM PARENT SHEEPNOSE TREE

Figure 4

The tree propagated from the sheepnose limb variation (Figure 1) is at the right; the other is from a bud from a normal limb of the same tree. The fruits of the progeny trees were typical of the limbs from which the buds were taken. Photographed at Citrus Experiment Station, Riverside, California, January, 1925.

orange seedlings in a commercial nursery in cooperation with the Citrus Experiment Station of the University of California. Buds were also taken from a normal branch of the same parent tree at the same time and propagated with those from the limb variation in order to make a comparative study of the progeny of a normal limb with that of the Sheepnose limb variation. The nursery trees of each of these propagations were transplanted to the progeny test orchard of the Citrus Experiment Station at Riverside, California, on July 2, 1917. The trees were set ten feet apart in the row along with progeny trees of other bud variations of the Washington Navel orange.

The orchard in which the progeny trees are located was planted on land where nothing but winter grain crops had been previously grown. Winter and summer legume cover crops have been grown and plowed under each year since the planting of the trees in order to improve the soil conditions but no other fertilizing materials were used until the spring of 1924. The trees have made a healthy and normal growth and produced their first crop of fruit during the season of 1920-21.

Progeny Performance Records

The two progeny trees of the Sheepnose limb variation have borne a total of 766 and 1,257 oranges respectively during the five years since they came into bearing all but 36 of which have been typical of this strain and more than ordinarily uniform in strain characteristics. The remaining 36 fruits produced by these trees have shown the typical coarse texture of the Sheepnose strain but have not had the shape characteristic of fruits of this strain due to the reduction in size of the enclosed navel or secondary orange. Figure 4 shows progeny trees propagated from both the Sheepnose limb and the normal part of the parent tree and Figure 3 shows two typical fruits produced by these two progeny trees.

The two progeny trees of the normal limb of the parent Thomson tree have produced a total of 470 and 217 oranges respectively during the performance record period of five years since the trees came into bearing. These fruits have all been typical of the Thomson strain with the characteristic variations which normally occur in the crops of trees of this strain.

The progeny trees of the Sheepnose strain have produced more oranges each year than the progeny trees of the Thomson portion of the parent tree but on account of their smaller average size the differences in the weight of the crops of the trees of the two strains has been less than would be indicated by their number.

The foliage of the two progeny trees of the Sheepnose limb variation is more finely branched and the leaves are narrower and more sharply pointed than the normal foliage of the parent tree and similar to the parent limb variation from which they were propagated. The foliage of the two comparative progeny trees of the normal limb of the parent Thomson tree is typical of the foliage characteristics of trees of the Thomson strain. The difference in the foliage of trees of the two strains is shown in Figure 4.

Conclusion

The foliage and fruit characteristics of the Sheepnose limb variation of the parent Thomson tree have been transmitted to progeny trees through bud propagation.

The occurrence of the Sheepnose limb variation in the parent Thomson tree and the behavior of its progeny as reported herein indicate that the presence of trees of the Sheepnose strain in established navel orange orchards is doubtless due to the unintention propagation of limb sports of this character in commercial nursery practice.

Owing to the small size, unusual shape, rough texture or rind and inferior quality of the juice of the fruits of the Sheepnose strain it is an undesirable strain for commercial propagation in the Southwest.

These facts together with those previously reported emphasize in a marked manner the importance of bud selection in citrus fruits in order to avoid the perpetuation of undesirable strains.

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TABLE I.—Records of annual production of progeny trees propagated in 1915 from a limb variation of the Sheepnose strain in a tree of the Thomson strain of the Washington Navel orange with comparable records of progeny trees propagated from a normal Thomson limb in the same parent tree. All these trees were planted in the orchard July 2, 1917.

Strain	Tree No.	Number of Fruits Produced					
		1920-21	1921-22	1922-23	1923-24	1924-25	Totals
Sheepnose	1	60 S	157 S	256 S	205 S	72 S	750 S
				3 C	9 C	4 C	16 C
	2	75 S	251 S	442 S	280 S	189 S	1237 S
				9 C	5 C	6 C	20 C
Thomson	3	18 T	84 T	103 T	175 T	90 T	470 T
	4	4 T	47 T	26 T	96 T	44 T	217 T

S indicates fruits of the Sheepnose strain, C indicates fruits of coarse texture and normal or flattened shape and T indicates those of the Thomson strain.

Geology Teaches Eugenics

With the passing of John Mason Clarke, of Albany, on May 29, 1925, the world has lost not only one of its leading paleontologists, but one of its great men of all science. No paleontologist excelled him in discernment of the morphology of invertebrate Paleozoic fossils or in knowledge of the Devonian of North and South America; no philosopher has ever seen more clearly the lessons that these fossils teach or expressed them in more beautiful diction. . . .

The philosophy of Clarke's paleontologic studies is to be found mainly in three of his papers, namely, his address to the Paleontological Society as its first president (1911); "The philosophy of geology and the order of the state," being the presidential address to the Geological Society in 1916; and "Organic dependence and disease," published in 1921. His conception of what the life of the past should mean to the living human world may be summed up as follows:

> Paleontology is . . . the most far-reaching of all the sciences. In it lies the root of all truth, out of it must come the solution of the complex enigmas of human society. [The great significance of evolving life as seen throughout the geologic ages came to Clarke from his studies of the earliest phases of the parasitic or dependent conditions of life —a study of mutual organic associations that led to commensalism, sessility and finally to parasitism. These modes of life involve] the essential abandonment of normal direct, upright living and the benefactors thereby are types of life which Nature has cast out and aside as hopeless . . . Individual and locomotive independence, it would seem, has been the major function and prime determining factor in the progress of life. . . . All progress in life, as reckoned in terms of man, has come through independence and through those lines of animal life in which independence has been maintained at any cost . . . Rescue of dependents is therefore not a part of the scheme of Nature, except through the exercise of intelligence.
>
> On the other hand, the communal life of the social insects shows that "socialism and communism have been tried out and found wanting, and Nature holds conspicuously before the eye of the State the warning that they have nothing either for the growth

of the spirit or the progress of the intellect.

Nature makes for the individual, and this truth is registered on the tablets of the earth . . . Over and over again the dominant race has started on its career as an insignificant minority struggling for its existence against an overburden of mechanical and vital obstacles, armed only with specific virtues which have little by little fought their way into the foreground, and by so doing consumated their upward purpose . . . The majority is purely numerical, while wisdom and truth may rest with the minority . . . The voice of the people is not the voice of God.

The paleontologist, looking at the record of life on the earth, says to the state: "Be intelligently guided in the treatment of hereditary community parasites, defectives, congenital or confirmed misdemeanants, whatever the form of degeneration may be, by recognition of the presumption that in so far as they can not be physiologically corrected, they are abandoned types in which there lies little hope of repair.

A study of John M. Clarke's works shows clearly he was one of the greatest paleontologists of his time and one of the geniuses of science, "standing on the mountain-top and catching the first rays of the rising sun," pregnant with new views of nature. But an intimate knowledge of his life also reveals that his path to eminence was hewn out with much labor among his beloved fossils, taxing to the full the many-sided equipment that was his from home, college and environment. *Schuchert, C. and Rucdemann, R.* John Mason Clarke (Obituary), *Science*, 62:117, Aug. 7, 1925.

An Important Field of Research

PLURIPOTENZERSCHEINUNGEN, Synthetische Beitraege zur Vererbungs—und Abstammungslehre, by VALENTIN HAECKER. Pp. 210 with 26 illustrations, price $2.25. Jena, Verlag von Gustav Fischer, 1925.

Professor Haecker attempts to organize a large body of familiar facts. Why, for instance, does albinism tend to appear as an occasional variation in so many animals and plants? Why does a character develop in one way at normal temperature and in quite a different way at an artificial temperature? In short, he seeks to study genetic characters at the critical period between gametogenesis and birth. This is one of the branches of biology that most deserves work at present, and the author has brought together a great amount of useful material. It would not be expected that this presentation would be final or in every way satisfying. It represents merely one of the first steps on an important road.

P. P.

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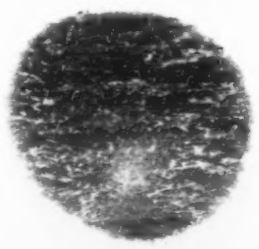

FITTER FAMILIES FOR FUTURE FIRESIDES

The Kansas Eugenics Contest

HILDEGARDE WALLS JOHNSON
Kansas City, Mo.

Note:—The Kansas "Fitter Families" contests receive occasional mention in the newspapers, but we know of no connected history of the movement. The members of the American Genetic Association will therefore be especially interested in this account, which has the approval of Dr. Sherbon, in active charge of this work.

It may be as well to state that we are publishing this article entirely for its news value, and not as an indication that the Association either supports the movement or approves the method of popularizing eugenic ideas. We must recognize that humans and livestock are controlled by the same laws of heredity. In spite of this fact we should not take it for granted that it is either possible or desirable to apply those laws in the same way in the two cases, if for no other reason than that the objects to be attained are so entirely different. The adoption of terms used in stock judging is especially to be deplored as tending to give eugenics more of the barnyard flavor which is certain to discredit it in the minds of many people.—Editor.

REGARDLESS of Max O'Rell, Americans do know who their grandparents were. But, just how much we know about how they lived, the vocations they pursued, the ills they were heir to, and the causes of their death, is a different matter.

Wiggam, in his much discussed book, "The New Decalogue of Science," says, "the three ideals (of eugenics) of health, sanity, and energy seem not only perfectly safe objectives but also obtainable ones." Further on he says, "Owing to the fact that a man is a network of many ancestors, and since every man carries within himself a host of family skeletons and a host of family virtues, none of which he may exhibit in his own body or character, it would be necessary to include three or four generations of his ancestors in estimating his racial value."

In Kansas a beginning has been made by which a permanent record of these traits may be kept. At the Kansas Free Fair in Topeka last September (1924), in a small frame building on whose ridge pole appears the slogan, "Fitter Families for Future Firesides," for the fifth time a clinic was held for the examination of those families who wished to have the beginning of a eugenic family history recorded.

The "Fitter Families" movement is the natural outgrowth of the Better Babies movement which began, as almost everyone knows, at the Iowa State Fair in 1911, when Mrs. Mary T. Watts, of Audubon, Iowa, was asked to supply an exhibit to interest the women who came to the fair.

Mrs. Watts hit upon the idea of judging the babies who were brought to the baby show, not according to their beauty, but according to their points of health and strength. She called three women physicians to her assistance, and together they examined fifty babies. An auspicious day it proved, for from that first clinic sprang into being the movement for Better Babies which has swept into the most remote corners of the United States! It is entirely worthy of remark that of the three physicians who examined the babies at that first clinic, not one has stopped one moment since in her work for the betterment of childhood.

Heredity a Factor

The original idea back of the Better Babies movement was that better care and better feeding would produce a marked improvement in babies just as it has in domestic animals. Indeed, the first charts used to score the babies were some prepared to score the stock in judging it. But one morning, Mrs. Watts received a plain post-card signed Chas. B. Davenport, Director of Experimental Evolution, Carnegie Station, Cold Spring Harbor, New York.

The card bore this one sentence:

"You should give fifty per cent to heredity before you begin to score a baby."

In the midst of the enormous correspondence that had grown out of the publicity given the clinic, Mrs. Watts neglected the warning and it slipped from her memory until the same time the following year, when she received another one-cent post-card from Dr. Davenport, which also bore but a single sentence:

"A prize winner at two may be an epileptic at ten."

This brought Mrs. Watts' entire attention to this phase of the situation, and hunting up the card of the previous year, she went with them to Dr. Florence Brown Sherbon, who had been one of the examining physicians at that momentous first clinic. Dr. Sherbon declared that her experience in judging babies—and she had been constantly engaged in it since that day in September, 1911— corroborated Dr. Davenport's statement, adding:

"Very often babies with high scores under our present plan are known to have bad heredity."

Thereupon these two women concentrated their attention upon finding a plan that would include heredity in the examination of young children. Several plans were tried tentatively before they evolved the idea of the "Fitter Families." They finally decided that the family must be examined as a unit, if they were to have the proper background from which to judge the babies fairly.

The First Clinic

An opportunity to try out the plan did not present itself until 1920, when Mr. Phil Eastman, Secretary of the Kansas Free Fair Association, offered the use of a building on the fair grounds for a health exhibit to Dr. Sherbon, who was then Director of the Division of Child Hygiene of the Kansas State Board of Health.

This was the opening she had been watching for!

Dr. Sherbon accepted Mr. Eastman's offer, and the campaign for "Fitter Families for Future Firesides" was launched!

Her first act was to call a conference of specialists to work out a technique to establish standards for judging families. Every physician accepted the invitation enthusiastically. Dr. Sherbon submitted for their consideration forms used by the Life Extension Institute, the Bureau of Education, the Eugenics Record Office of Cold Spring Harbor, and several others.

The result of this conference was the adoption of an examination blank providing for a complete record of every person examined, and the necessary information relating to the parents and grandparents of the family.

To a large extent, it was the application of the rules of animal husbandry to the human family, for heredity and environment are the determining factors in all animal growth. Environment, being purely external, is available for analysis, but only by trustworthy and impartial record can hereditary history be determined.

Little publicity was given the movement the first year. The first two families who came were personally solicited, but as soon as it became known that these examinations were really taking place, other families be-

gan to arrive. The first year, twenty-five families totalling ninety-nine persons were examined. During the first four years, seventy-eight families totalling three hundred and fourteen persons were examined. This year one hundred persons completed the examinations, bringing to four hundred and fourteen the total number of persons of whom a permanent eugenic record has been made.

The staff of examiners consists of an historian, who is the Professor of Eugenics from the State University; men and women physicians to give medical and structural examinations to the entrants of their own sex; an eye, ear, nose, and throat specialist; a dentist; a psychiatrist; a physiologist; and a laboratory technician. These specialists serve without recompense and no fee is charged the public. The entire expense of the examination is borne by the Fair Association as a demonstration to the citizens of Kansas of the importance of assembling a eugenic family history, of keeping complete family records, and of the value of a periodical health examination.

An exhibit is held by the Department of Biology of the University of Kansas in an adjoining tent, where the crowd is given full information concerning the methods and aims of "Fitter Families for Future Firesides."

But in the building where the clinic is held, no one is admitted except family groups who come to keep appointments made in advance. There is one exception to this rule: that a man or woman of marriageable age who wishes an examination in the interest of eugenics, will be admitted. The strictest secrecy is maintained throughout the examinations and no report is made except to the family examined.

The building where the examinations are made has been divided into eight rooms or compartments, by means of beaver board partitions seven feet high, set six inches above the floor. This is thoroughly calsomined and there are white muslin curtains at all doors and windows.

When the examination, which requires about three hours, is completed, the superintendent summarizes all findings of the various examiners and interprets them, giving whatever advice may seem necessary. Later a complete record is sent to the family, a copy being retained for statistical purposes. The Kansas State Board of Health sends each entrant a Health Certificate of Class A, B, or C, according to the results of the examination.

Families are classified according to size; small families, consisting of father, mother, and one child; medium families, consisting of father, mother, and two to four children; and large families, consisting of father, mother, and five or more children. Each year the Governor of Kansas has given a trophy to the family of each class which wins the highest score. Senator Capper has shown his interest by offering a bronze medal to every entrant whose average is A or B+, with no score falling below B. This year forty-two of the one hundred persons examined earned them.

Interest in "Fitter Families"

But these things are purely extraneous. The real enthusiasm is best illustrated by the farmer who drove his wife and five children fifty miles in a Ford, and then waited four hours for their examination, just for the sheer satisfaction of knowing that they were all right.

The State Fair, being the place the eugenic test was begun, seems to be the logical place to continue it. The people who attend, having seen the remarkable improvement that good care and intelligent breeding have made in live stock in latter years, have very many of them wondered why something of this sort was not done for the infinitely more important human family; so their minds provide a fallow field for the planting of this

idea. Because of these things, the Eugenics Committee of the United States of America, of which Irving Fisher is Chairman, has appointed a sub-committee on Eugenics and Exhibits at Fairs, consisting of Mrs. Mary T. Watts, chairman, the same woman who started the Better Babies movement; Dr. Florence Brown Sherbon, Professor of Child Care at the University of Kansas; and Dr. Elvinor Ernest, of Topeka. Their specific purpose is to introduce the Fitter Families Examination into State Fairs throughout the United States.

Certainly, as they grow up, the Better Babies are entitled to the continuation of the medical examination which is given them up to the age of six years. Nothing can so indelibly impress upon them the value of sound minds and clean bodies, as a regular and conscientious examination of the family's health. Furthermore, you may be very sure that the young man who knows the eugenic history of his family, will look for more than just a pretty face when he decides to marry and add his own branch to the family tree; just as the girl who knows the eugenic history of her family will be able to resist the whirlwind courtship of a handsome stranger—at least long enough to find out something about his background.

After all, the greatest resource of the nation lies in the good health of the individual, and it should be safeguarded with the care commensurate with its importance. The Better Babies, it is safe to assert, will grow up to provide "Fitter Families for the Future!"

In one of his delightful editorials, William Allen White says that what is going to be done throughout the United States is first done in his beloved State of Kansas. Prohibition and Equal Suffrage began there, Georgia was the second State to hold a "Fitter Families" Exhibit, hers being at the Tri-State Fair at Savannah. And when Georgia and Kansas are interested in the same thing, the other forty-six States will do well to find out what it is all about!

Inheritance of Mental Traits

DIE VERERBUNG GEISTIGER EIGENSCHAFTEN UND DIE PSYCHISCHE KONSTITUTION, by W. PETERS, professor of psychology in the University of Marburg. Pp. 400, with 8 illustrations, price $4. Jena, Gustav Fischer Verlag, 1925.

As the most complete review now available, of the liteature of the subect, Dr. Peters' book will be widely useful. He is critical in his handling of the data, but unfortunately not so critical of the data themselves and the way they were collected. He is not wholly at home in the field of genetics. On the other hand, he knows how to analyze his subject, to define his problems clearly, and to marshal the scattered evidence skilfully. The lack of an index is a strange omission in a scientific work.

P. P.

HEREDITY AND MENTAL DISEASE

A Review

Professor Myerson presents a severe criticism of current theories and methods of research in the field of the heredity of mental diseases.* He emphasizes throughout that the word "insanity" does not correspond to any biological entity but has merely legal significance. He holds that studies of the part played by heredity in mental diseases are practically worthless unless based throughout on the thorough diagnosis of all cases by trained psychiatrists. He is indeed inclined to doubt whether a sufficent understanding has yet been reached of the kind of mental disease which runs in families for any attempt at a detailed genetic analysis.

The book is divided into two parts. In Part I the author presents a survey of the more important groups of mental diseases and discusses briefly the causal factors with special reference to the part played by heredity. In Part II, he gives the case histories of groups of relatives admitted to a particular institution, and discusses the bearing of his analysis of them on the various theories.

The heterogeniety of mental diseases is emphasized. The author rejects the view that there is any predisposing or hereditary neuropathic element in the organic diseases of the brain and nerves, such as paresis, meningitis, brain tumors, conditions resulting from arterio-sclerosis, etc. In the case of psychoses due to alcohol or any other drugs, or dependent on bodily disease, as tuberculosis cancer, diabetes, pellagra, etc., he believes that constitutional differences, not necessarily hereditary, may play some part, but that the toxic condition is the main cause. He concedes that some cases of neurasthenia, psychasthenia and hysteria may represent minor cases of hereditary mental disease but holds that most of them are reactions of normal persons to extraordinary environmental causes and have no genetic significance. Similarly, he points out that epilepsy is not a unitary disease but a symptom dependent in many cases, and perhaps in all, on organic conditions. With respect to feeble mindedness, after removing from consideration that associated with cretinism or with gross physical abnormality, the class of Mongolian idiocy, the cases due to trauma, infectious diseases of childhood, etc., he finds a large mass in which there is undoubtedly a tendency to run in families. He is severely critical, however, of past attempts to fit the data on a Mendelian basis. He leans strongly to the belief that such cases originate in injury to the germ plasm. An interesting side light is some evidence indicating very low fertility and thus the absence of important eugenic menace from this class of the population.

This brings him to the group of important mental diseases which appear to run in families, viz., dementia precox, maniac-depressive insanity, paranoid psychoses, involution diseases and senile dementia. He describes the varied and often overlapping symptoms of these diseases for the layman. The difficulties in diagnosis are emphasized.

The detailed studies in Part II deal with the diseases of this last group. The data are drawn from the records of the Taunton State Hospital to which there had been 22,000 admissions in the period from founding in 1854 to 1916. Allowing for readmissions, he estimates that about 16,000

*The Inheritance of Mental Diseases, ABRAHAM MYERSON, professor of Neurology, Tufts College Medical School, Williams & Wilkins Co., Baltimore, 1925. 336 pages. $5.00.

persons are represented. About ten per cent of these (1547) were related to each other and represent 664 families. He has one case in which four generations have been in the hospital. In 23 cases, the admissions extend over three generations, in 333 cases, two generations are represented, while 307 are limited to groups of siblings or cousins. He comments on the fact that so far as he has been able to find, his one instance of four generations of hospital cases is unique. "Not many cases of four generation mental disease can be adduced because it is rare for mental disease to last four generations in one group."

In his data he finds a strong tendency for mental disease to run true to type throughout a family. There are paranoid families, maniac-depressive families and dementia precox families. He finds a slight indication that paranoid and maniac-depressive types in ancestors may lead to dementia precox in the descendant and that the latter may lead to congental feeble mindedness.

As with feeble mindedness, he is wholly unconvinced by the Mendelian interpretations, whether a generalized neuropathic taint is treated as a unit or separate units are hypothecated for the separate diseases. He is as severe in his criticism of the looseness of diagnostic criteria in the attempts at analysis by the biometric school. "The fact is that the inheritance of mental diseases is a clinical problem to be solved as any other clinical problem is solved by pathology and individual study and experiment. Until we have facts to offer for statistical analysis the statisticians and with them the professors of biology had better keep out of this field."

The conclusion which he reaches himself as the best working hypothesis is that familial mental disease is the result of injury to the germ plasm, an injury which either disappears in a few generations or increases in effect and causes the extinction of the line.

To the reviewer it appears that the author betrays an unduly hostile attitude to those who are approaching the problem from a different viewpoint than that of the psychiatrist. He is doubtless right in insisting on the necessity of adequate clinical diagnosis of cases. If biometricians and mendelians have frequently sinned in this respect in the past, it should not be concluded that their methods are inherently worthless, but merely that there should be such co-operation between the statistician, psychiatrist and professor of biology as will lead to an application of sound statistical methods to reliable data and to an interpretation made with an adequate background of biological knowledge.

The hereditary basis for mental disease may be caused directly by the action of toxic agents on the germ cells, as the author prefers to have it, or it may occur "spontaneously" through some inequality in the mechanism of heredity which is not related to any tangible environmental factor, as has been found for many characters. Having arisen, it may follow the Mendelian mechanism of heredity or it may follow some as yet unknown mechanism. These are difficult problems even with much more stable and easily diagnosed characters than mental disease and in organisms in which extensive experimental work is practicable. In man they can only be solved, if at all, by the combined use of all methods of attack.

In any case, the book is one which should be read by all who are interested in eugenics. It presents ably a viewpoint somewhat different from that to which they are most frequently exposed.

—*Sewall Wright.*

PRODUCTION OF TRIPLOID AND TETRAPLOID PLANTS

JOHN BELLING
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TRUE triploid plants are now known in Oenothera, Morus, Canna, Datura, Solanum, and other genera; while tetraploids have been found in Oenothera, Primula, Solanum, Datura, etc.

The chief characteristic of true triploids is a partial or total sterility; the triploid cannas, for instance, never (or rarely) producing seeds; and the triploid mulberries being seedless and parthenocarpic.

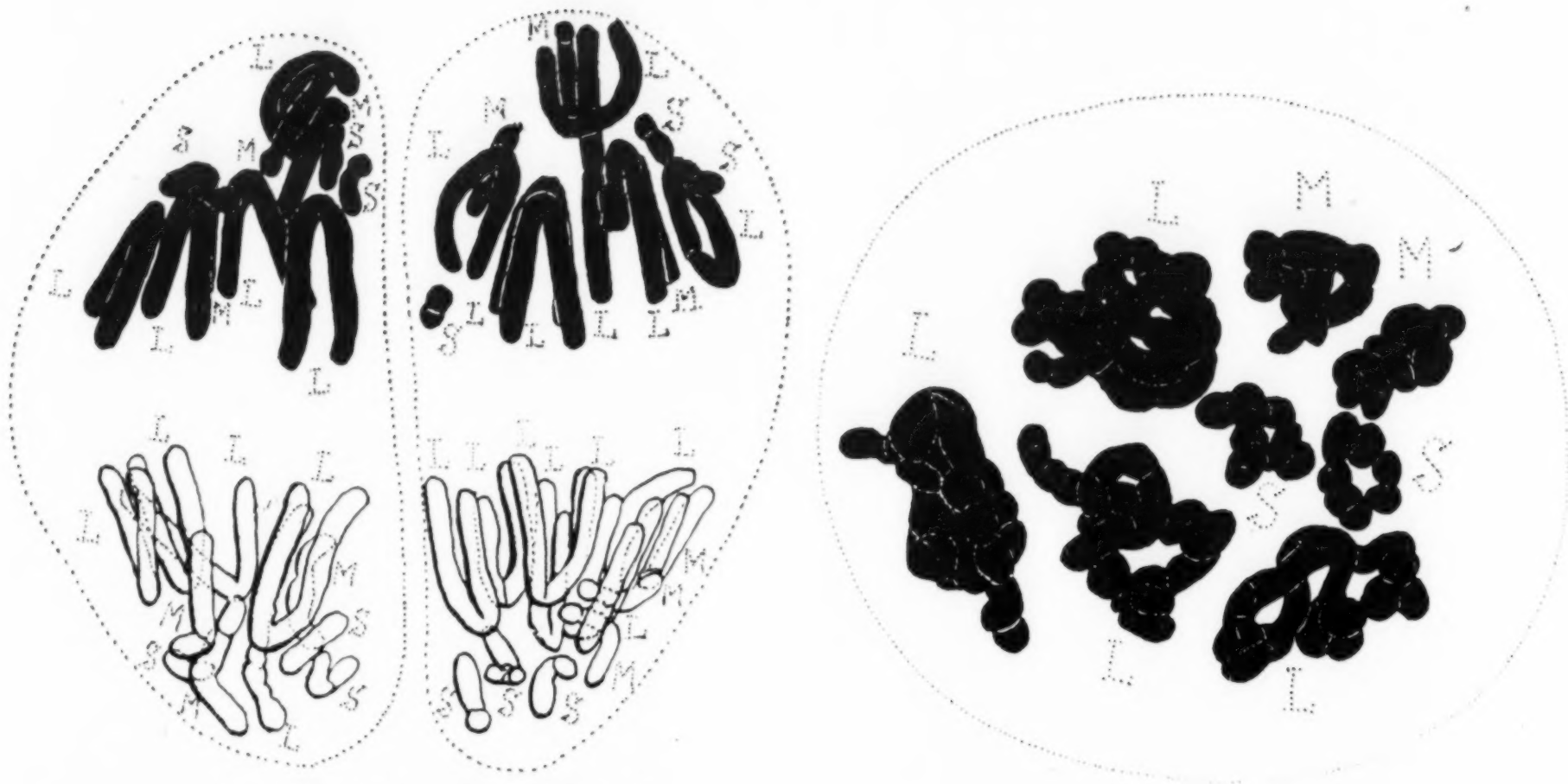
The characteristic of the tetraploids is the possession of much larger cells; amounting in spherical unvacuolated cells, such as pollen-mother-cells, to twice the volume of those of the diploid, and in vacuolated cells to even more.

The production of a triploid apparently originates with the doubling of the chromosome number in one of the gametes. This doubling is in many cases certainly due to a temporary chill, resulting in non-reduction or non-division during the maturation divisions of pollen-mother-cells, or megaspore-mother-cells (or to non-division in the somatic mitoses which give rise to the sub-epidermal tissue of a branch). The case was well exemplified in a field of Stizolobium (Mucuna) in Florida, where a temporary cold wave, in which however the freezing temperature was not reached, caused abundant production of 2n pollen-grains (and probably of 2n egg-cells also). The same phenomenon has been studied with the microscope in Uvularia (Journal of Genetics, 1925), and also in Datura, after chill in a greenhouse. From triploid plants which have originated in this manner, tetraploids can usually be produced by selfing, as in Oenothera. If tetraploids are of spontaneous occurence, as in Datura, triploids can readily be obtained by crossing them with pollen of diploids.

Triploid plants are already of commercial value for their flowers in the case of a few cannas. The advantage here consists in the dropping of their young seed-vessels, which set no seeds, and so do not prevent other trusses of flowers from appearing on the same stalk. Even the unremitting removal of all old stalks will not prevent, in many of the ordinary diploid cannas, the production of unripe seeds, to the consequent detriment of the prolonged flowering of the plant. In the triploid mulberries, of which many clones are grown in Japan, no seeds usually appear, although ripe fruits are formed. The production of seedless fruit is sometimes a desideratum.

The examples point to the desirability of the artificial production, by the action of temporary cold on the young flower-buds, of many other triploids, both in plants with ornamental flowers and in fruit trees. Triploids of most garden flower plants which are propagated as clones, and which have a prolonged flowering period, such as cannas and dahlias, would be of horticultural value. In cases of trees or shrubs, where seeds are undesirable, such as the Para rubber, for instance (and where the absence of seeds cannot be readily procured by making species crosses), triploid plants would be valuable. Even in fruit trees, triploids would be desirable, if parthenocarpy occurred; and the seedless triploid mulberries of Japan might well be paralleled by seedless triploid apples, plums, peaches, mangoes, avocadoes, cherimoyas, etc.

In fact the systematic production of



5L + 3M + 3S 7L + 3M + 3S 4L + 2M + 2S

CHROMOSOMES OF TRIPLOID HYACINTH

Figure 5

Pollen-mother-cell of triploid hyacinth, King of the Blues. This cell had divided into 11 and 13 at the first division, and again into 11 + 11 and 13 + 13 at the second division. The three sizes of chromosomes are obvious. The triploid number was 24 chromosomes, made up of 6 small, 6 medium, and 12 large. (Magnified 2,000 times.)

Late first prophase of pollen-mother-cell of the triploid hyacinth, King of the Blues. This cell shows eight trivalents, 2 small, 2 medium, and 4 large. Two of the large (on the right) seem larger than the other two. (Magnified about 2,000 times.)

triploidy, by chilling the young flower-buds, presents for the future the pleasing prospect of a method which will probably in time enable the horticulturist to remove the seeds from a number of the temperate, and especially from the tropical fruit trees. There is indeed some reason to think that it is the tropical plants (and several of our fruits and vegetables are essentially tropical plants) which are most readily affected by temporary chills in the desired manner.

With regard to tetraploidy, it offers a method (as yet quite unused) for the horticulturist to employ in increasing the size of the plant cells. This may be of prime importance in fiber plants as cotton, or flax, and perhaps in certain timber trees. But, with the increase in the size of the cells, the size of several plant organs is also increased. The production of larger flowers and of larger fruits is an important aim of horticulture. This will probably be facilitated by the use of tetraploidy; and its employment is not, as is that of triploidy, confined to plants propagated asexually, for tetraploids usually set a fair number of seeds. Hence tetraploidy may in the future be applied to perhaps all the chief fruits of the temperate and tropical regions, with fair prospects of success. Stems, such as those of the sugar-cane, may be increased in size by this method, and perhaps the increased size of the cells may facilitate the extraction of the juice. In fact, artificial tetraploidy seems to have before it a wide field in the improvement of the chief economic plants. The method is simple, and the principal material requirement is artificial ice, which is procurable now throughout the civilized world.

CHROMOSOMES OF CANNA AND OF HEMEROCALLIS

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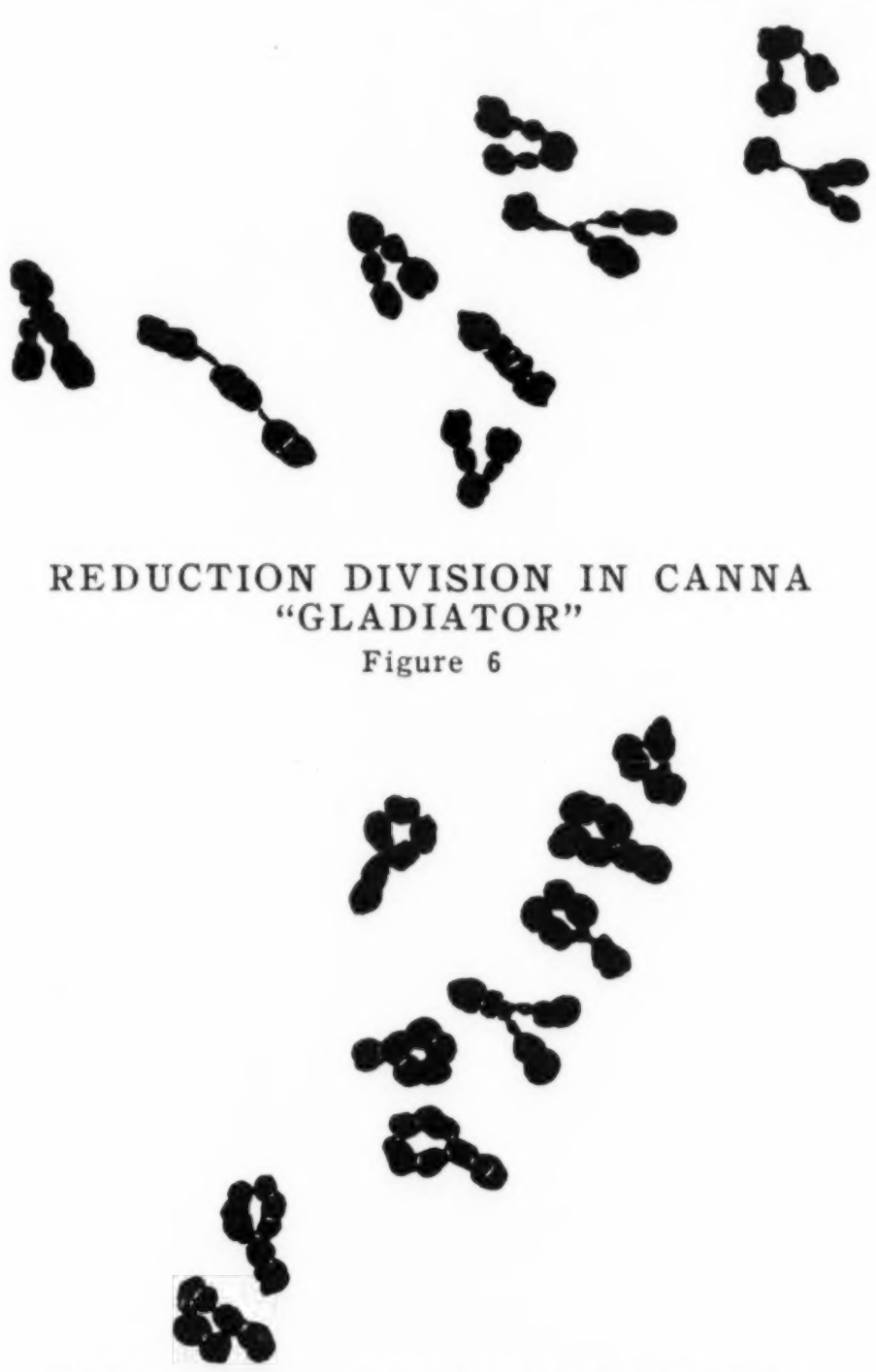
Carnegie Institute of Washington

Chromosomes of Triploid Cannas



REDUCTION DIVISION IN CANNA "GLADIATOR"
Figure 6

REDUCTION DIVISION IN CANNA "FIREBIRD"
Figure 7

CHROMOSOMES OF CANNA "PENNSYLVANIA"
Figure 8

Reduction division, showing single, double and triple chromosomes.

THE formation of trivalents at the first metaphase of a triploid was first demonstrated in Canna by the iron-acetocarmine method.* The detailed figures have, however, not yet been published.

Figure 6 is a camera drawing of the first metaphase in a pollen-mother-cell of the ornamental canna "Gladiator."

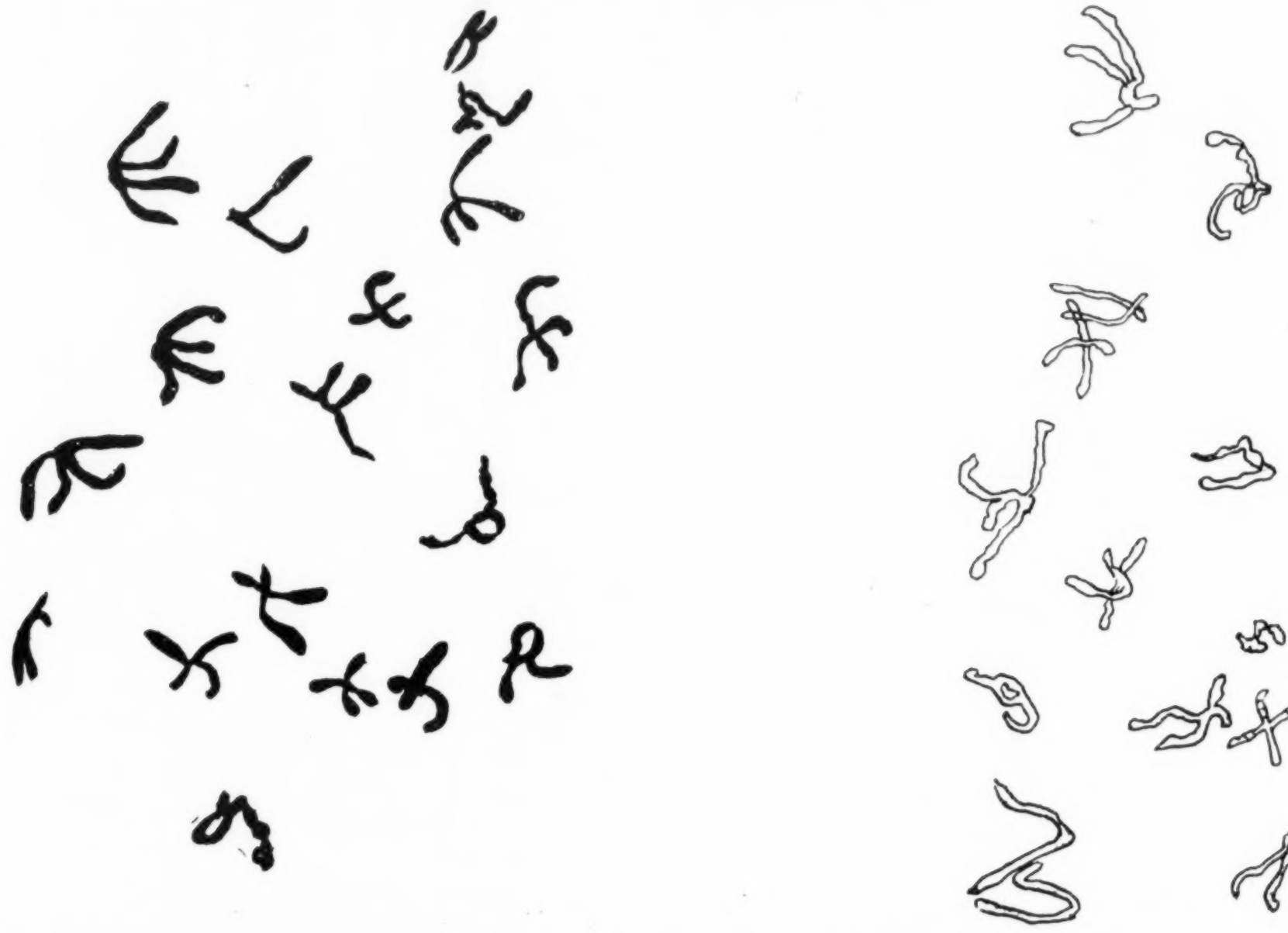
Figure 7 is the same stage of the Burpee canna "Firebird." In both these the 27 chromosomes form 9 trivalents which can be clearly seen.

Figure 8 represents the reduction division in the canna "Pennsylvania," which shows trivalents, bivalents and univalents.

The list of triploid plants in which trivalents have been seen now includes Canna, Datura, Hyacinthus and Hemerocallis.

**Proc. Nat. Acad. Sci.*, Vol. 7 pp. 197-201. 1921.

The Chromosomes of Hemerocallis Fulva



CHROMOSOMES SEPARATING AFTER DIVISION

Figure 9

Anaphase of first division of pollen-mother-cell of *H. fulva,* showing 15+18=33 split chromosomes.

The pollen and pollen-mother-cells of this plant have been investigated by no less than six observers, from 1882 to 1913* but its chromosome number has not been settled. Pollen-mother-cells mounted in iron-acetocarmine, however, showed that the plant was what may be called an irregular triploid, with varying numbers of trivalents, bivalents and univalents at the first metaphase. In this it resembles the large-flowered cannas, such as Pennsylvania and Louisiana, which have the triploid number of chromosomes. Occasionally there seem to be 11 trivalents at the first metaphase, as shown in Figure 10. The best counts of the anaphase (Figure 9) show 33 split chromosomes. The plant in Long Island is quite sterile, but spreads rapidly by the road-side.

TRIVALENT CHROMOSOMES

Figure 10

Metaphase of first division of pollen-mother-cell of *H. fulva,* showing eleven trivalents. Drawn with the camera.

*Tischler, G., Allgemeine Pflanzenkaryologie. Berlin. 1921-2.

EVOLUTION UP AND DOWN

A Review

TWO recent issues from the MacMillan Company evidently are products of the religious controversy on evolution, but may serve also in the education of the reading public in the biological sciences and the applications of biology in human welfare. It is remarkable that the applications of biology which have been carried so far with plants and animals have gained so little in popular comprehension, as shown by many writers on both sides of the controversy.

Everybody who wishes to conduct arguments against evolution will need Dr. O'Toole's book, "The Case Against Evolution," as well as those who wish to know the arguments that may be opposed to evolution. Few biologists are so well informed that they will not extend their knowledge by reading the book, or will not profit by seeing the need of more adequate presentation of biological facts, if errors of interpretation are to be avoided. All of the more prominent evolutionary facts and theories are stated and discussed in clear and often very forcible language, so that the book may have more value as a compendium of evolutionary biology than some that have been written to support evolution. Use as a textbook or work of reference is facilitated by a glossary and an index of author references as well as of subject material.*

The "case" is primarily against Darwinism, though the more prominent alternative theories are also weighed and found wanting. The criticism of logical absurdities and dogmatic assumptions by scientific writers is often very drastic, though the author disclaims any logical bias against the idea of evolution as such, and nowhere maintains "fixism" as opposed to "transformism." He even considers it possible that the evolution theory may be rehabilitated by "some great genius of the future," and that a "natural explanation of preadaptation" may be found. Thus no inconsistency could be charged if a companion volume, "The Case *for* Evolution," should appear.

The following passages from the foreword will make clear the standpoint and purpose of the book:

> The present work aims at setting forth the side of the question which it is now the fashion to suppress. It refuses to be bound by the convention which prescribes that evolution shall be leniently criticized. It proceeds, in fact, upon the opposite assumption, namely, that a genuinely scientific theory ought not to stand in need of indulgence, but should be able, on the contrary, to endure the acid test of merciless criticism.
>
> Evolution has been termed a "necessary hypothesis." We have no quarrel with the phrase, provided it really means evolution as an hypothesis, and not evolution as a dogma. For, obviously, the problem of a gradual differentiation of organic species cannot even be investigated upon the fixistic assumption, inasmuch as this assumption destroys the problem at the very outset. Unless we assume the possibility, at least, that modern species of plants and animals may have been the product of a gradual process, there is no problem to investigate. It is, however, a far cry from the possibility to the actuality; and the mere fact that an hypothesis is necessary as an incentive to investigation does not by any means imply that the result of the investigation will be the vindication of its inspirational hypothesis. On the contrary, research often results in the overthrow of the very hypothesis which led to its inception. We can, therefore, quite readily admit the necessity of evolution as an hypothesis, while rejecting its necessity as a dogma.
>
> . . . . . Recollection of the Galileo incident is, doubtless, salutary, in so far as it suggests the wisdom of caution and the imperative necessity of close contact with ascertained facts, but a consideration of this sort is no warrant whatever for an uncritical

*O'Toole, G. B. The Case Against Evolution. Price $3.00. The MacMillan Company, New, York, 1925.

acceptance of what still remains unverified. History testifies that verification followed close upon the heels of the initial proposal of the heliocentric theory, but the whole trend of scientific discovery has been to destroy, rather than to confirm, all definite formulations of the evolutional theory, in spite of the immense erudition expended in revising them.

The prospect, then, of a renewal of the Galileo episode is exceedingly remote. Far more imminent to the writer seems the danger that the well-intentioned rescuers of religion may be obliged to perform a most humiliating *volte face,* after having accepted all too hastily a doctrine favored only for the time being in scientific circles. It is, in fact, by no means inconceivable that the scientific world will eventually discard the now prevalent dogma of evolution. In that case those who have seen fit to reconcile religion with evolution will have the questionable pleasure of unreconciling it in response to this reversal of scientific opinion.

On the whole, the safest attitude toward evolution is the agnostic one. It commits us to no uncertain position. It does not compromise our intellectual sincerity by requiring us to accept the dogmatism of scientific orthodoxy as a substitute for objective evidence. It precludes the possible embarrassment of having to unsay what we formerly said. . . . .

In the present work, we shall endeavor to show that evolution has long since degenerated into a dogma, which is believed in spite of the facts, and not on account of them. . . . . .

Dogmatism, unfortunately, is not unknown in the scientific world, though it is not a scientific procedure to insist that people should believe, or should profess to believe, something they do not understand. If we are interested in anything to the extent of wishing to believe it, or to disbelieve it, the only scientific procedure is to go on, if possible, to first-hand knowledge and clear understanding. In default of knowledge that affords a basis of judgment, our believing or disbelieving is only formal and superficial, not scientific. Efforts undoubtedly have been made to teach Darwinism as a dogma or as propaganda against religion, with the reactions shown in the present unfortunate controversy.

It seems remarkable that so few of the religious writers have faced the biological facts for themselves, and have been willing to accept from their materialistic opponents the baseless notion of a contradiction or conflict between evolution and Christianity. For correcting this error, the book of Reverend Marshall Dawson, "Nineteenth Century Evolution and After" may be especially useful. It deals with the main question regarding the effect of evolution upon the ideals of moral responsibility that Christian teachers would maintain. New interpretations and adjustments are urged and justified by the profound differences that Mr. Dawson recognizes between the evolution doctrines of the last century and those of the present day.*

With natural selection presented as a merely mechanical process, and the evolution of species ascribed entirely to the action of the environment, it seemed that Darwinism had no implications of moral or social responsibility in human evolution. But this idea is only superficial; the knowledge of evolution has the effect of making our responsibilities much greater than ever before. Biologists know that degeneration is an evolutionary fact, no less than constructive progress to higher types of organization.

The Nineteenth Century idea of evolution, as an irresponsible mechanical effect, is described by Mr. Dawson as a "one-way ascending process," and Twentieth Century evolution as a "two-way reversible process." The belief in "natural selection of the best stock through survival of the fittest," carried with it an idea of "improvement guaranteed by mechanical tendency," that led people to consider "progress inevitable" and "veritable religion unnecessary."

The "two-way reversible" evolution is not irresponsible. The present attainments of civilization have a moral basis, and the foundation must be made stronger to sustain the structure and build it higher. Natural selection

*Dawson, Marshall. Nineteenth Century Evolution and After. The MacMillan Company, New York. 1924.

helped the primitive races through barbarism to civilization, but the conditions of civilization reverse natural selection. Retrogression to barbarism is inevitable through the "multiplication of the unfit," unless religion and science are united to meet the emergency. The function of natural selection as "the safeguarding biological principle," is clearly perceived and projected as a social and moral responsibility of the present day.

The presence of an emergency often clarifies thinking. Events have compelled the recognition of degeneration as one aspect of evolution. . . . .The break-down in civilized society of the safeguarding biological principle of the "survival of the fittest," which guaranteed the vigor of the stock under barbarism, is now recognized. Especially within the last decade have we been compelled to take account of a very different principle, the tendency toward the disproportionate multiplication of the unfit, which begins to prevail, biologically, in civilization. In short, the "natural" law which we now have to reckon with, for the present and future, is a leveling-down law. . . .

The Nineteenth Century experienced a thought-intoxication caused by a constantly expanding economic and intellectual horizon. Seizing upon the first incomplete formulation of the theory of evolution, it made "natural law" an exceedingly attractive substitute for theology, if not, indeed, for the Christian religion itself. The fact that in the social history of man evolution is at once progressive and retrogressive was lost sight of, until after the World War.

In prehistoric times the unchecked operation of disease, famine, cold, and enemies removed the weak members of the race before they had propagated their kind, leaving the more vigorous and alert individuals to become the parents of the next generation. This process is called "natural selection." Civilization, however, breaks down "natural selection." And, in turn, "natural selection" will break down civilization where no new blood can be brought in from other sources, or where no new and higher biological principle operates.

The removal of natural checks can go on, with safety, only where higher controls take the place of the discarded natural method. A civilization which removes natural checks more rapidly than it fosters higher controls commits suicide. Since civilization has been fatally predisposed to this course, its history, from the earliest times, has been one of self-destruction.

Race after race has brought to flower a high type of culture, and then has been seized by some deadly blight. The renewal of the human stock has come, each time, out of untapped reservoirs of barbaric vigor. So that, in a way, "natural selection" has seemed to continue in effect. But necessarily its term of operation, as a self-perpetuating process, is severely limited. With the rapidly diminishing size of the human "game preserves" where unspoiled barbarians could be bred, to restock the civilized areas, the process of "natural selection" becomes a vicious circle steadily narrowing in circumference until at last it dwindles to the vanishing point. The reservoirs of Nordic stock uncorrupted by civilization are gone; so that, if the white race fails, biologically, the earth's only recourse for fresh blood will be to Mongolia.

As long as there were new continents open to civilization, the steady march of biological degeneration could be escaped from, physically. The necessity for facing the situation with new eugenic principles and higher controls would hardly be felt. But when the last frontier has disappeared before the higher controls have been embraced, there is a sudden plunge or acceleration in the waste-products of society. And this sudden accumulation of waste-products brings to the attention of civilization the fact that it is chained to a corpse. . . . .

The successful reproduction of the human race can not longer continue on the inferior level of the action of body upon body. For the body has now become the smaller part of man. Reproduction, to be successful now, must move on the plane of the operation of personality upon personality. This argument will immediately recommend itself to prepared minds. In short, wisdom upon the biological future of the race begins in the barn-yard, but it does not end there because man's forehead differentiates him from the domestic animals.

Change, for the nineteenth century, meant only going forward. But change, in earlier centuries, had often meant going backward. Deeply engraved upon the records of the ancient world is the recognition of degeneration, as a part of the human process. The reading of what these ancient records had to say on this point provoked only humor, a decade ago. The expressions used are, indeed, quaint. An Assyrian tablet, dating from 2800 B. C., preserved in Constantinople, says:

> Our earth is degenerate in these latter days; there are signs that the world is speedily coming to an end; bribery and corruption are common; children no longer obey their parents; every man wants to write a book, and the end of the world is evidently approaching.

This is correct diagnosis and prognosis. If any one doubts it, let him look for Assyria on the map, or ask his steamship agent for a ticket to Ninevah or Babylon. For years, archaeologists have been digging up and patching together the fossil remains of high civilizations which rose in ancient times and which did degenerate to the point of extinction. The geographic world, as we know it, did not indeed come to an end; but the cultural and political worlds of Assyria, Babylonia, Egypt, Cnossos, and Greece, ended. One-half of the record of the ancient civilized world can only be interpreted in terms of retrogression.

The philosophy of a "fall," or degeneration, engraved upon Assyrian tablets and written into the Bible, is therefore no mere myth or fable. On the contrary, it represents an effort rightly to place and estimate in our thought-system, a factor which observation had shown to be active in the social order from the begining of men's recollection.

The questions thus raised and illustrated from the past are forcing themselves upon our attention. The wisdom of the extinct civilizations did not suffice for their needs. The Greeks carried many of the arts to the highest perfection that has yet been attained, but only a beginning was made in the development of the biological sciences, by Aristotle, Theophrastus and Hippocrates.

It need not be considered as mere selfishness on our part to be concerned with the future of our own race, but as an extension of the normal parental instincts as they become more enlightened regarding the positive and negative factors of human welfare and progress. There is no reason to expect that other races will be grateful for our efforts to impose on them a system that is destroying us. The need of charity beginning at home is again exemplified. It is clear that the racial problems are biological problems, and that a wider comprehension of the biological factors is necessary.

The controversy regarding evolution has revealed something of the extent of popular ignorance of biology, even among people who in other respects are well informed, and are leaders of their communities. Undoubtedly the discussion has aroused the interest of many to extend their knowledge and clarify their biological ideas, although the arguments show that the nature of evolution is misunderstood on both sides. There is no way to "prove" or "disprove" evolution, in the sense that the disputants assume.

Much of the argument about evolution is as useless as to try to prove that the sun rises. Men hidden in a cave might disagree about the time of day and yet might not go out to see the sun for themselves. Evolution can be seen only by looking, and it is not easy to get a clear view. New facts about the sun are still being learned by the intensive methods of observation that the astronomers have developed, and evolution is a still more difficult subject. Biology at the beginning seems as simple as "nature study" would make it, but is proving, as we go on, to be the most complicated and voluminous of all the sciences.

Instead of a hundred elements as in chemistry, hundreds of thousands of species of plants and animals have been described, each showing different solutions of the problem of life. The complexity of life no doubt is the reason why biology has been neglected so long, and is still neglected. Even among professional biologists there are many who overlook the fundamental evolutionary fact of the existence of so many species, and fail to consider the nature of species as groups of variable, interbreeding individuals. Thus the diversity of scientific opinions regarding evolution traces back to different groups of facts that have suggested the various ideas regarding the nature and causes of evolution.

Darwin framed an idea of the evolutionary process as a gradual change in the characters of species, which still seems correct to most biologists, though some believe that mutations also may give rise to new species. At the same time Darwin recognized natural selection, and saw that selection had a relation to evolution. Unfortunately, as now appears, Darwin took this relation

to be that of cause and effect, and he collected many data which have been supposed to "prove" evolution, by showing that it is due to natural selection.

Gradually it became apparent that this explanation, based upon the assumption of a direct, causal relation, with evolution dependent upon natural selection to actuate changes of characters in species, was a mistake. The relation of selection to evolution, while very important, is not the direct relation of cause and effect. Selective restriction of a group changes its constitution, at least in a statistical sense, but the survivors are not altered or caused to vary. Experiments have not shown any power of selection to produce changes of characters, though variations may continue in selected groups. Genetic variations were confused at first with environmental fluctuations of the characters, but are now recognized as distinct.

To get completely away from the idea of selective or environmental causes of evolution may be considered as an important step of progress toward a clearer and more general understanding. Darwinism was popular with the semiscientific public because it was supposed to prove evolution. The arguments appeared logical but were not wholly consistent with the facts, and in some respects were very misleading. There might have been no controversy if either the Darwinists or their opponents had perceived clearly enough that selection is not causative, but restrictive. Every character of every species is found to be variable, but the range of variation of some of the characters is restricted by natural selection.

Variation is restricted in harmful directions but is free to build out in other directions. Adaptations do not prove that selection causes evolution, but only show that evolution goes on. Preadaptation is a fact to be recognized, though we can not explain it. "The use does not produce the instrument, but the instrument occasions the use."

The two processes, evolution and selection, should be recognized as different in character and not causally related. Selection, far from accounting for evolution, does not even suggest an explanation. Those who seek mysteries may be commended to biology. The more they learn about life the more they will wonder, and the less they will be affected by the fictions of ignorance or of premature formulation that would make ignorance pass for knowledge by inflating it with words. Froude's paraphrase of Lucretius still describes the state of knowledge, or ignorance, of causes.

> . . . Organization is not contrivance, but immeasurably superior to contrivance. What it is we can not tell. We see only that the organs which we so much admire do not come into existence complete, as we should expect to find them if they were made with a determinate purpose. They are developed slowly, age after age, in successive modifications of a single type, the fish's fin becoming the wing of a bird, or the arm and hand of a man, the fish's scales becoming the bird's feathers; the horse's hoof a variation of the finger nail.

The practical issues do not turn upon belief or denial of evolution, or upon particular theories of evolution. The new social responsibility is felt as soon as the effects of adverse selection are recognized. The same condition of adverse selection has been reached in our civilization as in the urbanized civilizations of the past, and our prospects of survival may be no better, unless we can enlighten our ideals and change the incidence of selection.

Through the advance of biology, our civilization has arrived quite suddenly in a few years, on the brink of a responsibility that is all the more real and pressing because it has been so completely overlooked and neglected in the past — the responsibility that comes with knowing the effects of selection. The tree of knowledge is ripening another fruit that brings us a new conscience, or at least a new consciousness, of good and evil. Certainly

the churches will not fail to recognize the eugenic responsibility. The issue is not to be avoided, with every agency of agricultural improvement teaching the effects of selection on plants and animals. It may be more than a coincidence that Storrs, Connecticut, where Mr. Dawson lives, is the seat of the State Experiment Station. Consideration that is being given to cabbages and pigs will not be denied to children.

Whether we believe in evolution or in special creation of species, the facts of heredity and selection are the same. Selection controls reproduction, through survival of better or worse. Any group of living things deteriorates if selection cuts off the best lines of descent. We see this as clearly in relation to mankind as with any group of plants or animals that can be subjected to breeding experiments.

How mankind originated may remain a mystery, but we know that children are like their parents and other relatives, and have no reason to be doubtful that races or nations will deteriorate if the more capable families are extinguished through parasitism and sterility. We know that many civilizations of the past developed to the urban stage and then decayed and perished. And we now see that the same factors of adverse selection, with the same tendencies to racial deterioration and extinction, are at work in our present civilization.—*O. F. Cook.*

Selection Not the Motive Power

I, too, entertain the feeling that natural selection does not, and can not, produce new species or varieties, or cause modifications of living organisms to come into existence. On the contrary, its sole function is to prevent evolution. In its action it is destructive merely, not constructive—causing death and extinction, not life and progression. Death can not produce life; and though natural selection may cause the death of the unfit, it can not produce the fit—far less evolve the fittest. It may permit the fit to survive by not killing them off if they are already in existence; but it does not bring them into existence or cause improvement in them after they have once appeared. We must look to other agencies for the causes of evolution. A closed gate may block a road, but it does not push the traveler into a new path, or, indeed, cause him to move at all. It is a mere static obstruction, not a dynamic force. In a similar manner natural selection prevents evolution along certain lines; but it is not a dynamic force compelling progress along other lines. The motive power of evolution must be sought elsewhere.—*Alexander Graham Bell.*

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